AN EXPLORATION OF CHILDHOOD OBESITY ACROSS ETHNIC GROUPS IN COVENTRY

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Contents

List of tables

List of figures

List of appendices

Dedicated to Ross and Roisin

Not everything that can be counted counts, and not everything that counts can be counted.

Albert Einstein

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Author contributions

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Qualitative studies: The coding framework was developed by MM and reviewed by WR, RJ and FB.

Declaration

This thesis is submitted to the University of Warwick in support of my application for the degree of Doctor of Philosophy. It has been composed by myself and has not been submitted in any previous application for any degree.

List of publications including submitted papers

Journal articles:

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- Murphy M, Boardman FK, Johnson R, Robertson W. 7.1-O8. Parental beliefs of family health, diet, physical activity and weight: findings from a qualitative study in an ethnically diverse population. 1st World Congress on Migration, Ethnicity and Health, 19th May 2018, University of Edinburgh (Oral).
- Murphy M, Robertson W, Johnson R, Boardman FK. OP24 Eliciting children's perceptions and experiences of health, diet, physical activity and weight through the draw, write and tell technique. Society for Social Medicine, 61st Annual Scientific Meeting, 5–8 September 2017, University of Manchester (Oral).
- Murphy M, Robertson W, Johnson R, Boardman FK. An exploration of childhood obesity across ethnic groups in Coventry: A mixed methods study. Warwick Medical School Research Student Symposium, 6th June 2017, University of Warwick (Poster).

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Abstract

Background

Ethnic disparities in childhood overweight in the UK, and the cultural and contextual basis of disparities, are not well understood. The aims of this research were to identify patterns in childhood overweight across ethnic groups; explore child and parental perspectives and experiences that may contribute; and consider the implications for service design.

Methods

A mixed methods approach was utilised as follows: 1) a systematic review of the factors associated with adiposity in children from minority ethnic groups; 2) multilevel analysis of child measurement data for primary school children; 3) qualitative draw, write and tell interviews with an ethnically diverse sample of children aged 9-10 years; and 4) qualitative focus groups with parents from selected ethnic groups. Mixed methods analytical integration was performed using a joint display, following a thread and triangulation.

Results

Study 1 highlighted the lack of existing evidence to understand the basis of ethnic group disparities in childhood adiposity. Study 2 (n = 56, 409) found age and sex –related patterns of ethnic disparities in childhood overweight and obesity, indicating that children from Black African and Caribbean and Bangladeshi backgrounds had significantly higher odds at age 4-5 years vs White British. The same pattern was found for girls aged 10-11 years, whilst boys from South Asian, Black African, White Other and Mixed ethnic groups had significantly higher odds at this age. Study 3 (n=26) revealed that children viewed health as a choice, however ethnic group-specific experiences were not strongly apparent. Study 4 (n=35) identified universal and ethnic group-specific features of parents' lives influencing weight, emphasising the importance of cultural-contextual interactions upon family health behaviours. Mixed methods analytical integration allowed for a more complete appraisal of methods and understanding of the research issue.

Conclusions

The findings provide a detailed understanding of the cultural and contextual basis of ethnic disparities in childhood overweight, upon which to direct the planning of public health services.

Abbreviations

Adj zBMI	Adjusted zBMI
BA	Black African
BAC	Black African Caribbean
BC	Black Caribbean
BME	Black and Minority Ethnic Groups
BMI	Body Mass Index
CDC	Centre for Disease Control and Prevention
CEB	Community Energy Balance
CI	Confidence interval/ credible interval
CLAHRC	Collaboration for Leadership in Applied Health Research and Care
DIC	Deviance information criterion
ESL	English as a second language
EST	Ecological Systems Theory
FFH	Families for Health
FMI	Fat Mass Index
FSM	Free School Meals
HSE	Health Survey for England
IMD	Index of Multiple Deprivation
IOTF	International Obesity Taskforce
KS2	Key Stage 2
LSOA	Lower Super Output Area
MCMC	Markov Chain Monte Carlo
MCS	Millennium Cohort Study
NCMP	National Child Measurement Programme
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
NIHR	National Institute for Health Research
NS-SEC	National Statistics-Socioeconomic Class
OBOL	One Body One Life
Ofsted	Office for Standards in Education
ONS	Office for National Statistics
OR	Odds ratio
Ov/ob	Overweight and obese
PA	Physical activity
PAL	Physical activity levels
PCT	Primary Care Trust
PE	Physical education
PHE	Public Health England
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SA	South Asian
SD	Standard deviation
SE	Standard error
SEM	Socioecological model
SEP	Soceioeconomic position
SES	Socioeconomic status

SFT	Skinfold thickness
UK	United Kingdom
VPC	Variance Partition Coefficient
WB	White British
WC	Waist circumference
WHO	World Health Organisation
zBMI	Body Mass Index z-score

Chapter 1 Introduction

1.1 Chapter outline

This introductory chapter begins with an overview of the thesis and a background to childhood obesity across ethnic groups. An overview of Coventry as the research setting is provided. The final section introduces the study's methodology and the rationale for this methodology, and research governance and funding.

1.2 Overview of thesis

1.2.1 Purpose of study

The purpose of this thesis was to explore the factors influencing childhood overweight and obesity across ethnic groups in Coventry, focusing on the *cultural* and *contextual* basis of childhood obesity development. In addition, it was felt both valuable and necessary to explore the relationship between obesity and ethnicity in the broader UK context, in order to address gaps in the wider existing evidence base and ensure both local and national relevance of the findings. The research should be considered formative, as it attempts to understand the phenomenon and develop theory to guide evidence-based practice (Nastasi & Hitchcock, 2016), with consideration of both the *theoretical contribution* of this research as well as the *implications* for health services practice. As a formative, exploratory and pragmatic piece of research, a *mixed methods approach* was considered the most suitable manner in which to explore the phenomenon, hence an additional purpose of the research was to consider the ways in which a mixed methods approach can contribute to understanding a phenomenon, particularly within the fields of public health and applied health sciences research.

1.2.2 Structure of thesis

An outline of the thesis structure is provided in Table 1.1. The literature review focuses on pertinent issues to the research topic, including: 1) an overview of childhood obesity in the UK; 2) a summary of the key issues in relation to ethnicity as a factor within public health research; 3) the theoretical basis for the development of childhood obesity; and 4) identification of the main gaps in the existing literature base. The main body of the thesis consists of four original research study components: a systematic review; an analysis of quantitative data; and two qualitative research studies. Each of these study components are first reported as standalone studies, with a summary of the individual research questions, methods, results and strengths and limitations of each. The findings from these four mixed method study components are then brought together formally in a dedicated mixed methods analytical integration in Chapter 6. The discussion focuses on the contribution of the findings to: 1) answering the research questions; 2) understanding the theoretical basis for the development of childhood obesity; 3) local public health practice; 4) filling the identified gaps in the existing literature; and 5) identifying outstanding gaps the literature.

Table 1.1. Thesis map

Chapter no.	Chapter title	Summary of content
1	Introduction	1) Literature review – childhood obesity in the UK – ethnicity in public health research – theoretical basis for childhood obesity – gaps in the existing literature base 2) The research setting 3) Methodology and rationale
2	Study component 1: Systematic review	Systematic review of factors associated with adiposity in children aged 4 – 11 years from minority ethnic groups in the UK
3	Study component 2: Analysis of quantitative data	A multilevel analysis of individual and contextual factors contributing to ethnic disparities in adiposity in primary school children in Coventry
4	Study component 3: Qualitative study 1	Children's perspectives and experiences of health, diet, physical activity and weight
5	Study component 4: Qualitative study 2	Parental perspectives and experiences of family health, diet, physical activity and weight
6	Mixed methods analytical integration	Integration of findings from four study components
7	Discussion and conclusions	• Key findings and contribution to theory • Implications of the research • Remaining gaps in the evidence base • Conclusions and original contribution

1.2.3 Why this topic?

The basis for this research was conceived through a collaborative project between the University of Warwick and Coventry City Council, through the NIHR Collaborations for Leadership in Applied Health Research and Care (CLAHRC) for the West Midlands. The CLAHRC identified a need to investigate childhood overweight and obesity in the diverse population of Coventry, in order to contribute towards identifying appropriate approaches for tackling childhood overweight and obesity.

My personal interest in this topic comes from my background as a Community Nutritionist in East London, working with a vastly diverse population to help prevent and manage childhood obesity locally. Through delivery of obesity prevention and weight management programmes, I became aware of the important ways in which culture and context influenced the obesity-related behaviours of children and families. This lay the foundations for my interest in inequalities in health, leading to a research position at University College London developing and testing the effectiveness of a pilot intervention to manage adolescent obesity in a deprived, diverse borough in North East London. With this grounding in both public health service *research* and *practice*, I was especially driven to focus on the practical, implementation value of this research for service and intervention design. Having had this experience, I was keen to develop a strong partnership with Coventry City Council in order to ensure the continued relevance of the research for Coventry. This was achieved through a consistent presence within the public health team, regular reviews of progress and periodic feedback of findings. My hope is that this research contributes meaningfully to supporting Coventry in planning public health services that best meet the needs of their population, and to the wider UK evidence base concerning ethnic inequalities in childhood obesity.

1.3 Literature review

1.3.1 Overview of childhood obesity

Childhood obesity is a significant public health problem globally and within the UK, having an impact on both the short-term and long-term health and wellbeing of a child. The consequences of obesity during childhood include psychosocial problems such as low self-esteem and lower quality of life (Griffiths *et al.*, 2010), and clinical comorbidities including asthma, musculoskeletal complaints and obstructive sleep apnoea (Egan *et al.*, 2013; Narang & Mathew, 2012; Paulis *et al.*, 2014). Weight-related risk factors for cardiovascular disease and type 2 diabetes also have an onset during childhood (Freedman *et al.*, 2007; Reilly *et al.*, 2003). Children who are obese are more likely to be obese during adulthood (Reilly *et al.*, 2003), and childhood and adolescent obesity is directly related to early mortality and chronic disease in later life (Craig & Mindell, 2014). There are also financial implications: obesity currently costs the NHS £5 billion per year to manage (Department of Health, 2011). It is predicted that by 2050, the UK could become a mainly obese population (Butland *et al.*, 2007), in which case the children of today will suffer an even larger burden of obesity-related consequences as adults than we do today.

At present in the UK, 30% of boys and 29% of girls aged 2 – 15 years are considered to be overweight or obese, with around half of these in the obese category (Craig & Mindell, 2014). Tackling obesity has been a feature of UK government policy since 1992 (Universities of Leeds and Glamorgan and the London School of Hygiene and Tropical Medicine, 1998). Yet, obesity levels remain high and evidence suggests that the prevalence of obesity continues to rise in adolescents, although is beginning to stabilise in younger children (van Jaarsveld & Gulliford, 2015).

Obesity ultimately arises in an individual when there is a sustained energy imbalance over time. However, a complex web of factors gives rise to this imbalance: over 100 variables have been identified that directly or indirectly influence obesity positively or negatively, and modifiable determinants at the individual and community level include diet, physical activity, the food and physical activity environments and individual psychology (Butland *et al.*, 2007).

Specifically, an energy dense, high-fat and low-fibre dietary pattern is associated with increased adiposity in children (Ambrosini *et al.*, 2012), whilst the evidence base for the association between free sugars and body weight is also growing (Malik *et al.*, 2013; Te Morenga *et al.*, 2013). Regular physical activity decreases risk for obesity and high sedentary behaviour increases risk (Joint WHO/FAO Expert Consultation, 2003).

1.3.2 UK migration patterns and history

To understand the role of ethnicity upon obesity, it is important to understand the migratory history of minority ethnic groups in the UK, as this provides some context for any potential relationships. For the purposes of this thesis, there are two key periods of relevance for international migration to the UK. The post-World War II migration boom was the first key period, with migration largely from Ireland and New Commonwealth countries (the Caribbean, Africa, and the Indian subcontinent) in response to labour demand and focused recruitment drives (Castles *et al.*, 2014). This migration largely ceased following economic stagnation in the UK, resulting in severe restrictions upon migration from the Commonwealth, although family reunion continued throughout the 1960s and 70s. Most African-Caribbean and Asian migrants arriving during this period received formal citizenship although still faced discrimination, low status jobs, low social mobility and residential segregation. Migrants from the Indian subcontinent were diverse, consisting of Hindus from the western Gujarat region of India, Sikhs from the eastern Punjab region, and Muslims both from the west part of Pakistan and from East Pakistan (now Bangladesh) (The National Archives, 2018). Partition with Pakistan contributed to peak migration from Bangladesh in the late 1970s and early 1980s, whilst there was a significant movement of African-Asians from Uganda and Kenya in the 1970s following unrest (Office for National Statistics, 2016c). Community-formation and maintenance of cultures, language and religions has been facilitated largely by the degree of segregation experienced by minority ethnic groups (Castles *et al.*, 2014). By the mid-1980s, the emergence of UK-born second and third generation descendants of migrants contributed to the greater social visibility of migrants from these countries into distinct 'minority' ethnic groups, and it is this group that accounts for the majority of the 7 million 'ethnic minority population' in the UK (Castles *et al.*, 2014).

The second crucial period of migration relates to the flow of refugees and asylum seekers in the early 21st century, from Eastern Europe, Africa, the Middle East and Sri Lanka (Office for National Statistics, 2016c). In addition, the free movement of peoples across European borders resulting from the formation of the European Community has further contributed to contemporary migration patterns.

1.3.2.1 Societal and political response to migration

'Multiculturalism' was pursued in the UK as a matter of public policy, under the Race Relations Acts, in order to ensure the rights of individuals from minority ethnic groups and acknowledge cultural difference. However, there have been periods of unrest in response to incidences of institutional racism and rising unemployment experienced inequitably by minority ethnic groups, and an unexpected consequence of this approach is greater separatism (Castles *et al.*, 2014). Multiculturalism has been eclipsed more recently by concerns about threats to national security and identity, with ideas of 'social cohesion' and 'British values' dominating public policy in relation to immigration in recent years

(Castles *et al.*, 2014; Schierup *et al.*, 2006). Alongside the low social status generally experienced by migrants in the UK, this constitutes what Schierup *et al.* (2006) refers to a ‘dual crisis’ of national identity and the welfare state: the declining capacity of the welfare state in maintaining equity, and the inability of the state to accommodate incremental ethnic diversity.

One final noteworthy phenomenon is that of cultural pluralism, defined by Pantoja *et al.* (1976 p.130) as

> “the condition in a society in which individuals, on the basis of ascribed or attained characteristics, are able to form and develop communities along the differences of race, age, sex, religion, language and cultural life styles. These communities are open systems and members can select to belong to one or more communities at the same time.”

Although generally used in reference to societies, this concept also has relevance at an individual level in relation to notions of ethnic identity, which arise throughout this thesis.

1.3.3 UK policy context

1.3.3.1 Childhood obesity policy

Childhood obesity has formally been acknowledged as a public health priority for the UK government since 1992, and has continued to feature through policies including *Saving Lives: Our Healthier Nation; Choosing Health, Making healthier choices easier; Healthy weight, healthy lives: a cross-government strategy for England; A call to action on obesity;* and most recently *Childhood Obesity: A Plan for Action* (HM Government, 2016; Jebb *et al.*, 2013).

The scale of the problem was detailed in the influential report *Tackling Obesities: Future Choices,* which urged policy makers to acknowledge obesity as a complex problem with multiple drivers, tackled only by systemic change and interventions at multiple levels, including individual, local, national, and global (Butland *et al.*, 2007).

A change in strategic direction has been observed over the course of this policy progression from a 'top-down standard-setting', to a 'liberal paternalism' approach of voluntary action, partnership building, and a greater emphasis on the role of personal autonomy in behaviour change (Jebb *et al.*, 2013; Knai *et al.*, 2016). *A call to action on obesity* (Department of Health, 2011) effectively moved away from central government action, charging local areas with developing strategies and commissioning services for the prevention and treatment of obesity (Jebb *et al.*, 2013), with a renewed ambition to achieve 'a sustained downward trend in the level of excess weight in children by 2020'. This direction was consistent with large scale health care reform which handed responsibility for public health to local authorities, on the basis that each community has different characteristics and what works best for one will not necessarily work well for another (Department of Health, 2011).

Various government-led initiatives have been launched in support of tackling childhood obesity, ranging from voluntary commitments from industry (the Responsibility Deal; front-of-pack nutritional labelling); to legislative action (school food standards; television advertising restrictions; soft drinks industry levy); to cross-government partnership (e.g. the *Healthy Places Planning Resource* and Department of Transport's *Active Travel Strategy*); to social marketing campaigns targeting individuals and families (Change4Life and Start4Life) (Department of Health, 2011; HM Government, 2016; Jebb *et al.*, 2013). In addition, clinical and public health guidance has come from the Chief Medical Officer's physical activity guidelines and an array of guidelines from the National Institute for Health and Care Excellence (NICE), including *Working with local communities to prevent obesity; The most appropriate* *means of generic and specific interventions to support attitude and behaviour change at population and community levels;* and *Promoting physical activity, active play and sport for pre-school and school-age children and young people in family, pre-school, school and community settings* (Jebb et al., 2013). *A call to action on obesity* also emphasised a continued commitment to the National Child Measurement Programme (NCMP) (Department of Health, 2011), discussed in more detail later.

However, the most recent government strategy for tackling childhood obesity (*Childhood Obesity: A Plan for Action)* has been roundly criticised for its lack of ambition (Knai *et al.*, 2016), and despite the long-term presence of obesity on the public health agenda, there is a lack of evidence of effectiveness of policy interventions, perhaps reflective of the complexity and magnitude of the problem (Jebb *et al.*, 2013). This policy and practice background provides a grounding to recurring themes throughout this thesis: the roles of individual autonomy, community, local government, national government and so-called 'upstream'[1] forces upon child and family health behaviours.

1.3.3.2 Inequalities in health

Inequalities in health have been recognised in the UK for a long time, highlighted through a series of reports including *The Black Report* (Department of Health and Social Security, 1980) and *The Acheson Report* (Acheson, 1998), with varied uptake by governments of the time (Hunter *et al.*, 2010). Addressing health inequalities[2] was taken seriously as a priority for UK government in the *Saving Lives: Our healthier nation* white paper of 1999 (Secretary of State for Health, 1999), although some criticised a regression in the government's ideological stance of tackling inequalities in the subsequent *Choosing Health* white paper of 2004

[1] Upstream refers to "features of the social environment, such as socioeconomic status and discrimination, that influence individual behaviour, disease, and health status" Gehlert *et al.* (2008)

[2] Health inequalities refers to differences in health status or in the distribution of health determinants between different population groups (World Health Organization, 2018)

(Department of Health, 2004; Hunter, 2005). Since then, *The Marmot Review* was a key paper in recognising social position as the key determinant upon health, demonstrating inequality in the socioeconomic distribution of health, and setting out an ideological stance that viewed righting these inequalities as a matter of social justice (Marmot Review, 2010). A public health white paper (*Healthy Lives, Healthy People*) setting out actions for tackling the wider social determinants of health followed (HM Government, 2010).

However, although *The Marmot Review* acknowledged the social and health disadvantage experienced by particular ethnic groups, it has been criticised for overlooking the unique inequalities that arise out of 'racialised social identities', which operate in addition to socioeconomic circumstance (Salway *et al.*, 2010). Broadly speaking, minority ethnic groups experience poorer health than the majority White population in the UK, although this pattern is not consistent across all diseases nor across all minority ethnic groups, or indeed within ethnic groups (Nazroo, 2001). 'Equal service for equal need' has underpinned National Health Service (NHS) delivery for decades, supported by the Race Relations Acts, 2010 Equalities Act and 2012 Health and Social Care Act, however, a review of Primary Care Trusts (PCTs) found a lack of compliance with the Race Relations Act across a third of Trusts (Parliamentary Office of Science and Technology, 2007). In addition, qualitative research with NHS commissioners revealed ethnic equity to be a peripheral concern within national healthcare policy (Salway *et al.*, 2016), and commentators have criticised the 'stop-start' nature of UK policy attentions to ethnic inequalities in health (Bhopal, 2014). Migratory health has also been relatively lacking from the health inequalities agenda (Jayaweera, 2014). Most recently, Public Health England (PHE) produced a Health Equity Report with a focus on ethnicity, reporting variable improvements in ethnic inequalities in health (e.g. a reduction in ethnic inequalities in low birthweight, but no change to ethnic inequalities in child excess weight) and a lack of analytical power to detect trends in inequality by ethnic group (Public Health England, 2017b).

1.3.4 Definitions and measurements

1.3.4.1 Overweight and obesity

Overweight and obesity is defined as the "*abnormal or excessive fat accumulation that may impair health*" (World Health Organization, 2015). The most commonly used method of classifying children as overweight or obese is body mass index (BMI), which is a measure of weight-for-height, calculated by dividing weight in kilograms (kg) by height in metres (m) squared (kg/m^2). For children, reference charts are used to chart BMI, which allow a child to be compared to a reference population (their expected growth) based on age and sex. BMI is not a direct measure of adiposity i.e. it is not able to calculate an individual's body fat. However, it correlates reasonably well with a person's body fat and at a population level will be an accurate reflection of the prevalence of adiposity (National Obesity Observatory, 2009). It is a practical tool, which can be implemented easily, accurately and non-invasively. A high BMI is indicative of meaningful risk of morbidity in children (Reilly *et al.*, 2003) and is related to a high BMI in adulthood (Power *et al.*, 1997), for which there is a well-established evidence base for increased risk of obesity-related disease.

There is no agreed definition of overweight and obesity in children. A number of reference charts are in use in the UK, and different cut-offs are used to define overweight and obesity. The most frequently used reference data for the UK population is the British 1990 Growth Reference Curves (UK90) (Cole *et al.*, 1995). A limitation of this reference data is that the reference population were all of White ethnicity, which has implications for the estimation of overweight and obesity in non-White groups. BMI 'population monitoring' cut-offs are used for the purpose of identifying prevalence and trends in weight status, as detailed in Table 1.2.

Table 1.2. Population monitoring cut-offs for BMI based on UK90 reference data (Cole *et al.*, 1995; Cole *et al.*, 1998)

UK90 population monitoring BMI centile range	**BMI classification**
≤ 2nd centile	Underweight
> 2nd centile and < 85th centile	Healthy weight
≥ 85th centile	Overweight
≥ 95th centile	Obese

The National Institute for Health and Care Excellence (NICE) recommends different cut-offs for use in clinical settings; where overweight and obesity are assigned at the 91st and 98th centiles for BMI respectively (National Institute for Health and Care Excellence, 2014a).

The International Obesity Task Force (IOTF) reference data is also commonly used in research, based on data across six countries (Brazil, Great Britain, Hong Kong, the Netherlands, Singapore, and the United States), with thresholds for overweight and obesity extrapolated from the adult cut-offs of 25 kg/m^2 and 30 kg/m^2 respectively (Cole *et al.*, 2000). The use of both the UK90 and IOTF reference data in UK epidemiological research results in variation in prevalence of overweight and obesity observed across different studies, hence this report specifies the method used in the literature presented throughout the thesis.

One limitation in the use of BMI for this research is that standard cut-offs may not be appropriate for use in some ethnic groups. There is evidence that ethnic variation in body fat and anthropometry (e.g. height) may result in inaccuracies in the classification of weight status, and that this may contribute towards observed ethnic differences in overweight and obesity (Ridler *et al.*, 2009; Shaw *et al.*, 2007). Changes in the BMI thresholds used to indicate high risk of type 2 diabetes in adults from Asian, Black and other minority ethnic groups, from a BMI of 30kg/m^2 to a BMI of 27.5 kg/m^2 (National Institute for Health and Clinical Excellence, 2014), have led to some debate on whether specific ethnic cut-offs should also be used for children, although an expert group concluded that there was little variation across ethnic groups in the misclassification of children when IOTF cut-offs were used (Viner *et al.*, 2010). More recently, Hudda *et al.* (2017a) have urged the adoption of ethnic-group specific adjustments in the identification of childhood adiposity.

Other commonly used measures of body fat in children include waist circumference (WC), waist-hip ratio, waist-height ratio and skinfold thickness (SFT). These measures may more accurately measure adiposity, so can play an important role in the identification of excess body fat in some minority ethnic groups (El-Sayed *et al.*, 2011).

1.3.4.2 Ethnicity

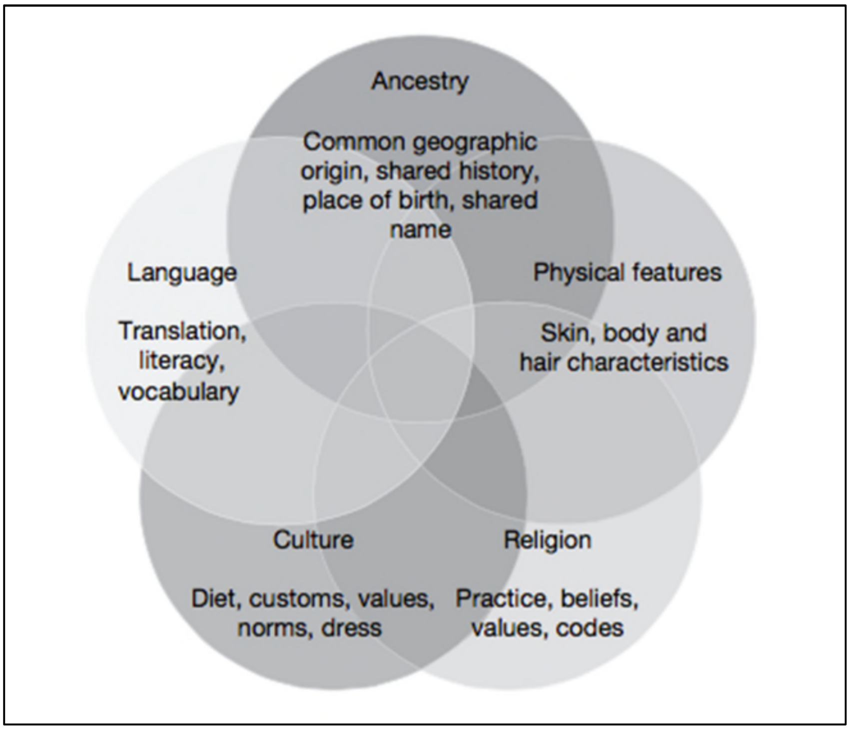
Throughout this thesis, the term 'ethnicity' is used to refer to a group to which people belong, and/or are perceived to belong, based on one or more of the following aspects, as outlined by Bhopal (2014):

- Shared origins or social background
- Shared culture and traditions which are distinctive, maintained between generations, and lead to a sense of identity and group-ness, and
- A common language or religious tradition

There is no one agreed definition of ethnicity, although the term is generally taken to incorporate a number of social, cultural and physical elements, as outlined in Figure 1.1.

Figure 1.1 Diagram illustrating the commonly used dimensions of ethnicity

(Liu *et al.*, 2012)



Ethnicity is distinct from the term 'race', as the latter is broadly a biological concept, is not well defined, and may not be helpful in epidemiological research, where researchers are attempting to understand the shared characteristics within a group that may help to explain an increased risk for poor health. However, race may form part of someone's ethnic identity (Bhopal, 2004).

In this research, the use of the term 'ethnic groups' refers to all ethnic groups, whilst the use of the term 'minority ethnic groups' refers chiefly to non- White British groups, although may refer more broadly to non-White groups where a cited study uses this classification (this will be specified). Within the literature, the White ethnic group is generally used as a reference population by which to compare relative risk of overweight and obesity, although occasionally the 'general population' is used as a reference, which uses an ethnically representative sample as a comparator.

Some consideration is also given to migration throughout the thesis, given its role in the formation of ethnic identity (e.g. through common geographical origin). As an extension, subsequent generations whose parents or grandparents were migrants are referred to throughout the thesis by the terms ‘second/third generation’. Although this terminology is problematic in that it gives little indication of individual ethnic identity, implies some degree of separatism from the general population, and perpetuates immigration status upon children and grandchildren (Bhopal, 2014), the terminology is preferable to ‘second/third generation migrants’ (since these individuals are not migrants). This distinction on the basis of migratory history is useful for studying cultural influences, since deep-rooted cultural differences, variation in gene/environment interactions and social discrimination and inequality remain important contributors to variations in health for subsequent generations of migrant families (Bhopal, 2014).

There are a number of limitations to studying ethnicity as a variable in health research. Firstly, the research often uses broad categories to define ethnic groups, which can mask within-group heterogeneity. As an example the ethnic group ‘South Asian’ is commonly used in UK health research; however this is a broad category that incorporates Indian, Pakistani and Bangladeshi ‘sub-groups’, each with discrete cultures, traditions and socio-demographic profiles. In addition, there are further distinctions within these sub-groups based on language and religion (Bhopal, 2004). Similar heterogeneity exists across the other broad ethnic categories, including ‘White’, ‘Black’, ‘Mixed’, and ‘Other’. Use of broad categories can make it difficult to identify clear patterns of variation in disease risk by ethnic group, as well as the underlying cultural and contextual influences that contribute to varying disease risk (Bhopal, 2014). Nevertheless, it is a common limitation in the research, mainly as a result of researchers wishing to create a larger sample base by combining sub-groups, upon which to draw more statistically powerful inferences (Bhopal, 2014). The lack of consistency in the ethnic categories used across health research contributes further to this ambiguity; for example, some studies will include a 'mixed' ethnic category, whilst others do not.

As ethnicity is dynamic in its nature (Bhopal, 2014) (i.e. an individual's perception of their ethnic identity may change over time; and the ethnic categories used in research may change over time as a better understanding of the role of ethnicity is built), comparability of data over time is also difficult. It is also worth stating that most health research is now based on self-selection of an ethnic category (Bhopal, 2014). Researchers must be mindful that research on defined categories of ethnicity does not provide a very complete picture of the complexities of an individual's own ethnic identity (just the category they feel they 'fit' into best, if indeed they choose to select a category) nor the ethnic identity that others perceive them to belong to. These limitations should be considered both in interpreting the existing literature, and in the design of study elements. It may be impractical and impossible to design a categorical, fixed measure that collects ethnic groupings with complete validity and allows for meaningful and robust analysis in the field of epidemiology (Mathur *et al.*, 2013). However, qualitative research may offer more scope for considering the multi-dimensionality of ethnicity in a study population.

Researchers in the field of ethnicity and health recommend taking the following measures in order to appropriately use ethnicity as a variable within health research (Bhopal, 2014; Burton *et al.*, 2010; Mathur *et al.*, 2013):

- Use measures of ethnicity appropriate to the research and locality, and do not generalise findings over time
- Describe how ethnic categories have been derived
- Describe the concepts that ethnic group classification is intended to represent

- Describe what role ethnicity is expected to play in the phenomenon being studied
- Test potentially confounding variables as an alternative explanation
- Where variation in disease prevalence by ethnic group is observed, conduct detailed examination of the relative importance of environmental, lifestyle, cultural, and genetic influences
- Recognise the potential influence of the researcher's personal values, including ethnocentricity, on research and policy making
- Recognise the limitations of ethnic categories and approach them critically
- Apply the findings to the planning of health services

Further consideration of the ethnic groupings used throughout this thesis, and the basis for these groupings, is provided in section 1.5.2.4 and in Appendix 1.

1.3.5 Ethnicity and health

The conceptual basis for how ethnicity may affect health is the influence of culture and context upon behaviour (Nastasi & Hitchcock, 2016). Given the low social status experienced by ethnic groups, some researchers propose that ethnic inequalities in health are driven by differences in socioeconomic position[3] (SEP) (Nazroo, 2003). However, the extent to which SEP explains the relationships between ethnicity and health remains unclear, with potential additional contributions from other factors such as geography, the environment and standard of living, experiences in society, discrimination, racial harassment, cultural practices and norms, lifestyle, and genetic or biological influences. In

[3] Socioeconomic position refers to *"socially derived economic factors that influence what positions individuals or groups hold within the multiple-stratified structure of a society"* (Galobardes *et al.*, 2007 p.220)

addition, the relationships and interactions between these influences appear to be disease-specific, ethnic group-specific and variable by gender and across the life course (Mathur *et al.*, 2013; Nazroo, 2001; Nazroo, 2003).

Myers (2009 p.10) proposes an integrative multidimensional biopsychosocial perspective:

> "at the core of the ethnic health disparities is differential exposure to psychosocial adversities moderated by inadequate access to and control over essential material, psychological, social, and health care resources over time."

Context is of central importance to the role of migration upon health. Migration is a complex determinant of health: with migration to the UK generally occurring from low and middle income countries, experiences of hardship generated by the social and political context of the country of origin may contribute substantially to ethnic inequalities in health upon arrival in the UK. In addition, the economic, physical and mental burden of migration is likely to have an effect upon health (Bhopal, 2014). On the other hand, in relation to obesity specifically, migration to the UK tends to be from regions with a low prevalence of obesity to a country with high prevalence, which may confer a protective effect for migrants upon arrival through lowered exposure to an obesogenic environment (Murphy *et al.*, 2017). In addition, the 'healthy migrant effect' proposes that immigrants are a highly selected sample of their native populations, with a tendency towards younger age, better health and socioeconomic advantage. Nevertheless, despite this initial advantage, overweight and obesity rates in migrant groups tend to approach or overtake those of the native population through a process of acculturation (Delavari *et al.*, 2013).

1.3.6 Prevalence of childhood overweight and obesity

Childhood obesity prevalence is unequally distributed across ethnic groups in the UK. However, a clear pattern of distribution has not yet been established, and there is a lack of agreement within the research about which ethnic groups are most at risk (El-Sayed *et al.*, 2011).

Table 1.3. shows the prevalence of overweight and obesity across ethnic groups in the UK based on analysis from the Health Survey for England (HSE) (Karlsen *et al.*, 2014a; Sproston & Mindell, 2006) and the Millennium Cohort Study (MCS) (Zilanawala *et al.*, 2015).

Table 1.3. Prevalence of childhood overweight and obesity across ethnic groups from the Health Survey for England and Millennium Cohort Study

	Ethnic group	n	Overweight %	Obese %
HSE, 2004 *Cross sectional survey; aged 2 - 15y; UK90 epidemiological cut-offs; figures weighted by sex*	General population (2001-2)	10823	14.5	16
	Black Caribbean	363	13	27.5
	Black African	341	12	29
	Indian	571	11.5	17.5
	Pakistani	494	12	20
	Bangladeshi	169	13	21
	Chinese	80	15	13
	Irish	1375	13	19
HSE, combined data from 1998-2009 *Cross-sectional survey; aged 2 - 15y; IOTF cut-offs; adjusted for year of data collection and excluding those with missing data on equivalised household income; (95% confidence intervals)*	White English	36,600	19 (18, 19)	6 (6, 6)
	White Irish	917	17 (14, 20)	6 (4, 8)
	White Other	1045	19 (16, 22)	8 (6, 10)
	Black Caribbean	1749	19 (16, 21)	9 (7, 11)
	Black African	1118	24 (20, 28)	10 (7, 12)
	Indian	1747	19 (16, 22)	6 (4, 7)
	Pakistani	2091	19 (16, 22)	8 (6, 10)
	Bangladeshi	1274	17 (12, 22)	10 (6, 14)
	Other South Asian	899	14 (11, 17)	6 (4, 8)
	Chinese	489	22 (13, 32)	3 (0,6)
	Other	868	19 (16, 23)	8 (6, 11)
MCS, 2015 *Longitudinal cohort study; aged 5y; IOTF cut-offs; survey and non-response weights to account for the sampling design and attrition between contacts; adjusted by ethnicity, sex and age*	White	15,003		5.5
	Indian	518		4.7
	Pakistani	926		6.5
	Bangladeshi	376		10.7
	Black Caribbean	487		11.1
	Black African	459		11.4
	Other	511		6.2

Table 1.4 shows the prevalence of overweight and obesity across ethnic groups in the UK based on analysis from the National Child Measurement Programme (NCMP) (Health and Social Care Information Centre, 2014b).

Table 1.4. Prevalence of childhood overweight and obesity across ethnic groups from the NCMP 2013/14

	Ethnic group	n	Overweight %	Obese %
NCMP, 2013/14 *Cross-sectional survey; Reception year (aged 4 - 5y) and year 6 (aged 10 - 11y); UK90 epidemiological cut-offs; (95% confidence intervals)*	**Reception year**			
	White	369,448	13.5 (13.4, 13.6)	8.8 (8.7, 8.9)
	Mixed	26,183	12.1 (11.7, 12.5)	10 (9.7, 10.4)
	Asian or Asian British	52,274	8.7 (8.4, 8.9)	10.4 (10.2, 10.7)
	Black or Black British	26,647	15.2 (14.8, 15.6)	15.6 (15.1, 16)
	Chinese	2,322	11.6 (10.4, 13)	7.7 (6.7, 8.9)
	Any other ethnic group	8,938	12 (11.4, 12.7)	11.3 (10.6, 12)
	Unknown	101,524	13.5 (13.3, 13.7)	9.6 (9.4, 9.7)
	Year 6			
	White	323,303	14.2 (14.1, 14.3)	17.6 (17.5, 17.8)
	Mixed	19,414	14.4 (13.9, 14.9)	21.4 (20.8, 22)
	Asian or Asian British	47,341	14.9 (14.6, 15.2)	23.8 (23.4, 24.1)
	Black or Black British	23,723	16.3 (15.8, 16.7)	27.4 (26.8, 28)
	Chinese	1,573	10.3 (8.9, 11.9)	18.9 (17, 20.9)
	Any other ethnic group	7,864	16.2 (15.4, 17)	24.3 (23.4, 25.3)
	Unknown	91,057	14.4 (14.2, 14.7)	18.8 (18.5, 19)

Black ethnic groups show a consistently high prevalence of overweight and obesity, particularly Black African children, whilst Chinese children generally show a low prevalence of overweight and obesity. The data on the Asian, mixed and other ethnic groups is less consistent. Analysis by subgroup indicates a particularly high risk in overweight or obesity for specific ethnic sub-groups and by sex. Black African boys, Black Caribbean girls and Bangladeshi boys and girls had an increased risk, whilst Indian children had a decreased risk (Dinsdale & Ridler, 2010; Dinsdale & Ridler, 2012; Dinsdale *et al.*, 2011; Karlsen *et al.*, 2014a; Ridler *et al.*, 2013; Sproston & Mindell, 2006; Zilanawala *et al.*, 2015).

On the other hand, a systematic review of UK cross-sectional and cohort data identified a slightly different pattern, with an increased risk in South Asian boys and Black girls relative to White children, and a decreased risk in South Asian girls and Black boys (El-Sayed *et al.*, 2011), however the search was limited to literature from 1980 – 2010 and the data included only covered the time frame 1978 – 2003, so does not include results from the NCMP. The NCMP suggests that ethnic variation in prevalence of overweight and obesity manifests in later childhood, since reception year children showed less marked differences across groups (Health and Social Care Information Centre, 2014a).

The MCS also looked at central adiposity (measured through WC z-score) in their sample at 5 years of age. Children in the Black ethnic group had the highest WC, whilst children from the Indian, Pakistani, Bangladeshi and mixed/other groups had the lowest, with z-scores significantly different to White children at the 95% level (Griffiths *et al.*, 2011).

There may also be variation in trends of overweight and obesity by ethnic group over time. The HSE data shows that the largest minority ethnic groups, with the exception of the Pakistani group, have seen relatively large increases in obesity since 2002 and exhibit a greater degree of variation over time compared to the White English group (Karlsen *et al.*, 2014a). Data from the NCMP is less clear in demonstrating a pattern in time trends, however a report by Dinsdale *et al.* (2014) does suggest that in year 6 (aged 10-11 years), inequalities in risk of obesity appear to be widening between Asian children and White children (with the rate of increase in obesity being higher in Asian children compared to White). However it is important to bear in mind that improvements in data quality of ethnic codes over time limit the ability to compare data across years for the NCMP (Public Health England, 2016).

There are limitations in each of the prevalence studies outlined above that impact upon interpretation. For example, in the HSE, findings for ethnic minority groups were compared to those for the general population from 2001 and 2002 combined. Since the prevalence of overweight and obesity rose over this time period, comparisons between ethnic minority groups and the general population may mis-estimate differences in prevalence (i.e. over-estimating for ethnic groups with a higher mean BMI and under-estimating for those with a lower mean BMI). In addition, fewer Black Caribbean, Black African and Bangladeshi children agreed to have their weight taken, at 62%, 69% and 67% respectively, than the general population (78%) (Sproston & Mindell, 2006), potentially resulting in respondent bias.

The existence of socioeconomic inequalities in risk of childhood overweight and obesity are very well established. The NCMP has consistently shown a gradient of increasing prevalence of overweight and obesity as deprivation (measured using Index of Multiple Deprivation for school postcode) increases (Health and Social Care Information Centre, 2014a). This gradient is steeper and more marked for year 6 children compared to reception year (aged 4-5 years) children. The HSE has also found prevalence of obesity to be highest in children living in households with the lowest equivalised incomes (Craig & Mindell, 2014). In their systematic review of socioeconomic disparities in childhood obesity in the UK, El-Sayed *et al.* (2012) concluded that to improve our understanding of the relationship, researchers need to account for both individual, household and ecological determinants in their analyses, as well as investigate the underlying mechanisms in the relationship more comprehensively.

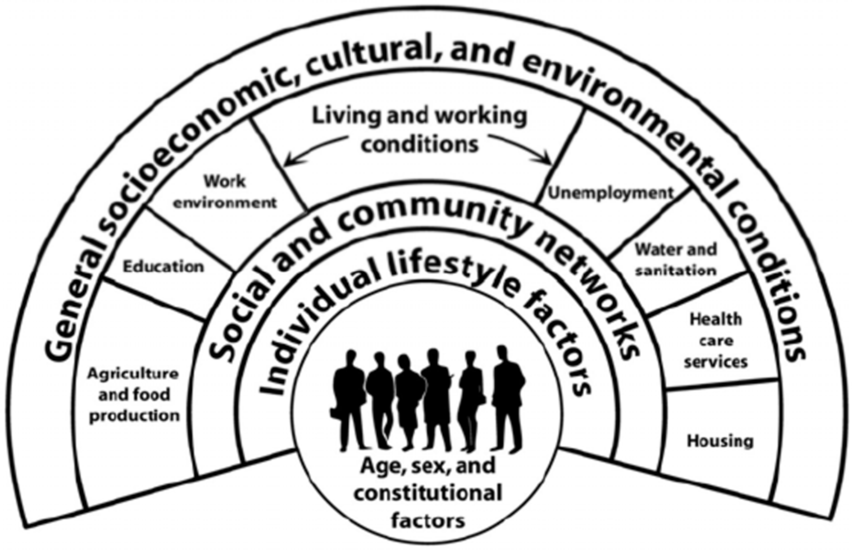
It is not clear the extent to which factors such as socioeconomic status confound the relationship between ethnicity and childhood overweight and obesity. A number of studies have found that when analyses are adjusted for indicators of socioeconomic status, such as equivalised household income, mother's education level, mother's employment status and area-level deprivation of school, the relationship between overweight and obesity and ethnicity alters, although significant associations often still remain after accounting for its effect (Higgins & Dale, 2012; Townsend & Ridler, 2009; Zilanawala *et al.*, 2015). El-Sayed *et al.* (2011) highlighted investigations of this relationship as a limitation in the existing literature on ethnic disparities in childhood obesity, with the relationship warranting additional research.

1.3.7 Determinants of childhood overweight and obesity

1.3.7.1 Conceptual basis for overweight and obesity

A conceptual framework is helpful in understanding the wide variety of influences upon lifestyle diseases that are unequally distributed across society, such as obesity. In their reports in health inequalities, both the Marmot Review (2010) and the Commission on Social Determinants of Health (2008) explain how the social determinants of health drive inequalities, with a focus on 'the causes of the causes'. Different groups in society will have different exposures to disease-causing influences throughout life, which are driven by experiences of material conditions, psychosocial support, behavioural options and biological factors. Responses to health care will also vary across groups on this basis. These exposures and responses are in turn influenced by a number of factors that reflect social position in society e.g. education, occupation, income, gender, ethnicity and race. Furthermore, these influences are affected by the political, economic, social and cultural contexts in which they are embedded, and accumulate over the lifecourse. These determinants are neatly summarised in the Dahlgren and Whitehead (2007) rainbow model below (Figure 1.2).

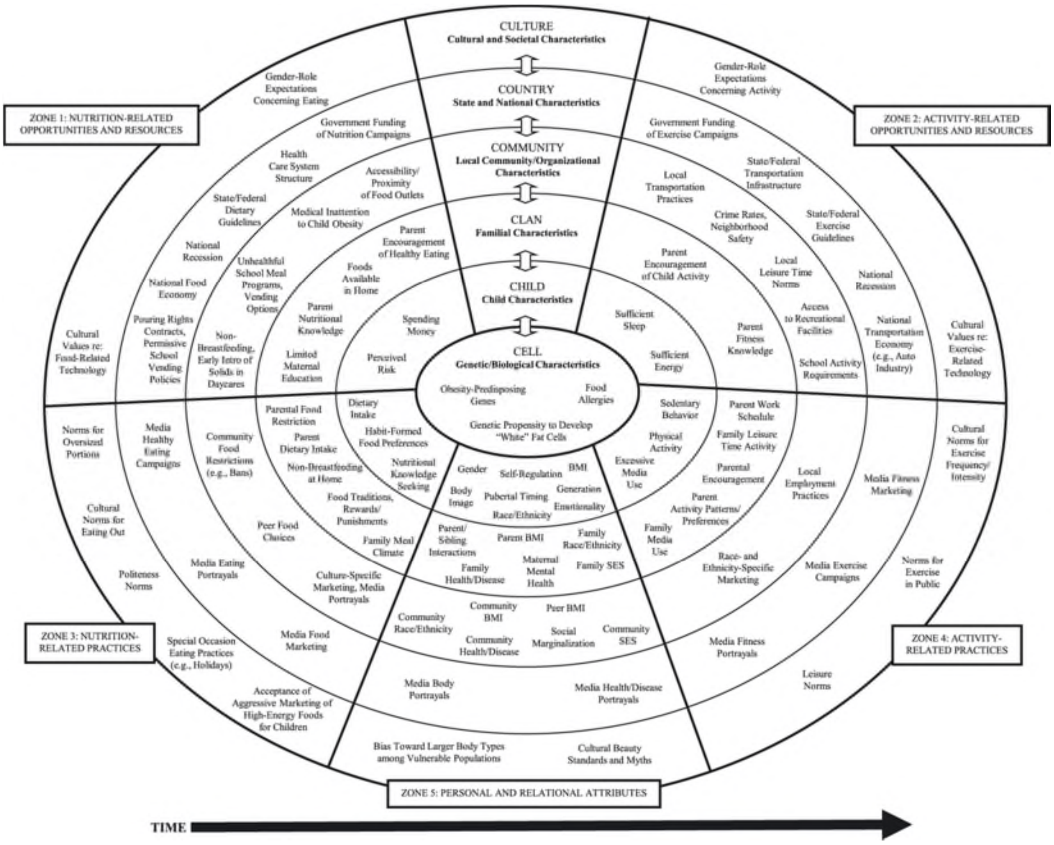
Figure 1.2 Dahlgren and Whitehead's rainbow model of the main determinants of health



1.3.7.1.1 Ecological systems theory and socioecological models

An ecological systems theory (EST) perspective, based on a 'bioecological model' of development proposed by Bronfenbrenner (1979), has been used widely in health behaviour research to provide a framework for understanding the multiple and interacting levels of influence upon the development of some diseases (Sallis *et al.*, 2008). Bronfenbrenner and Morris (2006) outlined five ecological systems: micro (home, school, peers, bio and social characteristics); meso (interactions between microsystems); exo (external environment e.g. parents' workplace); macro (social, cultural, political climate); and chrono (referring to changes over time). A number of authors have made use of the approach to outline the determinants of overweight and obesity at stages throughout childhood through socioecological models (SEM) (Davison & Birch, 2001; Neumark-Sztainer, 2005; Tabacchi *et al.*, 2007). Most recently, Harrison *et al.* (2011b) have built on these existing models and synthesised additional emerging research to produce the 'Six-Cs' model, with spheres of influence at the cell, child, clan, community, country and culture levels (Figure 1.3). However, the authors acknowledge that the model is not an exhaustive list of all possible factors influencing child weight status. Although the model includes race/ethnicity as a standalone contributing factor, and it is acknowledged that all elements of the model may interact with one another in some way, there is no explicit reflection on ethnicity *per se* and why it may be an important determinant.

Figure 1.3. The 'Six-Cs' developmental ecological model of contributors to overweight and obesity in childhood (Harrison *et al.*, 2011b)

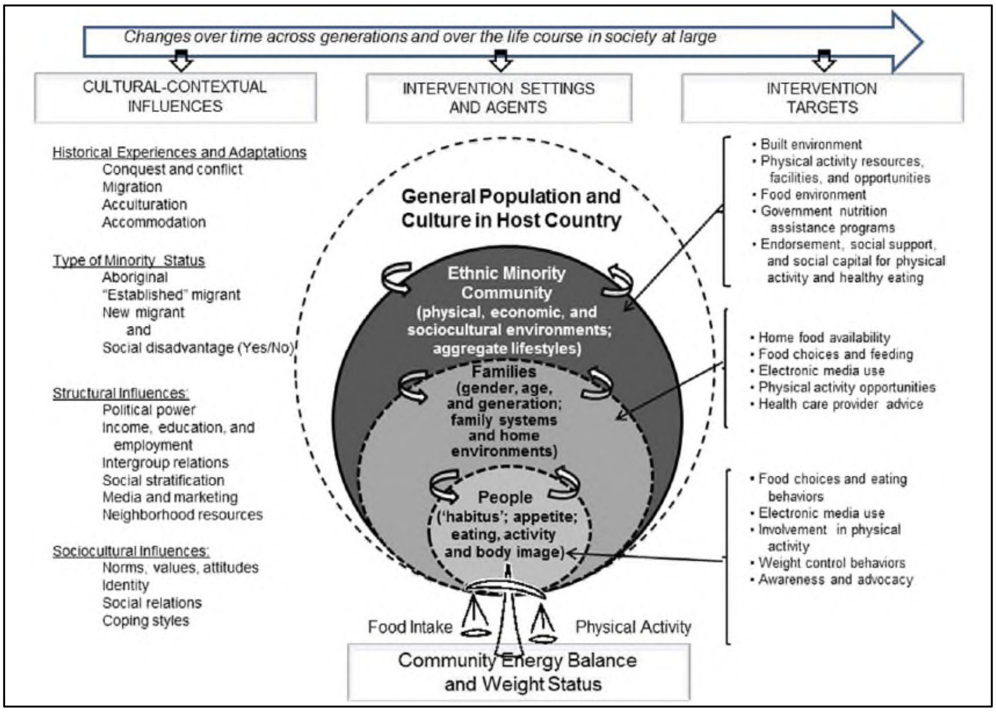


Following the design of their ‘systems map’ of the causes of obesity for the Foresight report, Butland *et al.* (2007) recommended their work be followed up with a series of ‘sub-maps’ specific to groups within the population, including ethnic groups, to indicate the relative strength and importance of influencing factors and their interactions, although at the time, the authors lacked the evidence upon which to base the design.

1.3.7.1.2 Conceptual basis for overweight and obesity in minority ethnic groups

Kumanyika *et al.* (2012) identified a gap in the literature for socioecological models of obesity that specifically applied to socio-culturally distinctive and socially disadvantaged populations, and sought to develop a model to conceptualise the cultural influences on high risk of obesity in minority ethnic populations. The investigators searched the literature for theoretical articles and conceptual frameworks related to cultural and structural influences on food, physical activity, and obesity. The resulting model (Figure 1.4) was intended to support understanding of the cultural and contextual influences upon obesity in minority ethnic populations, as well as considerations for the design of community-level interventions. The 'Community Energy Balance' (CEB) concept reflects their focus on community level influences upon food intake and physical activity.

Figure 1.4. The Community Energy Balance model of cultural and contextual influences upon obesity for minority ethnic populations (Kumanyika *et al.*, 2012)



The model considers the spheres of influence (people, families, communities, and host country characteristics) as intervention settings and agents. Cultural-contextual influences are the potential stressors that can positively or negatively influence food intake and physical activity, and tend to distinguish / separate the minority ethnic population from the majority population. Although the framework is intended to guide intervention design, it is largely untested, and the authors encouraged further development of the framework. This framework is discussed in more detail in Chapter 7.

1.3.7.2 Ethnic variation in determinants of obesity

El-Sayed *et al.* (2011) and Gatineau and Mathrani (2011) highlight a lack of literature investigating how contextual factors differ across ethnic groups within the UK and to what extent they can explain differences in obesity prevalence. El-Sayed *et al.* (2011) listed socioeconomic status, physiology, cultural behaviours, discrimination and acculturative stress as potential determinants requiring further investigation in the relationship between ethnicity and obesity. A summary of variation in the determinants of child obesity are outlined in Table 1.5, adapted from Murphy *et al.* (2017).

Table 1.5 Known and potential sources of variation in the determinants of obesity related to ethnicity and migration

Factor	Ethnicity	Migration	Influencing factors
Genetic, physiological and epi-genetic factors	Theoretically possible that some genetic differences underlie vulnerability of different ethnic groups to obesity, although none have yet been identified (Murphy *et al.*, 2017). Some ethnic differences in physiology are acknowledged e.g. greater volume of brown adipose tissue in South Asian adults (Bakker *et al.*, 2014). There is ethnic variation in ages of growth and sexual maturation upon body composition affecting child obesity measurement (Hudda *et al.*, 2017a; Shaw *et al.*, 2007).	The 'Thrifty phenotype' hypothesis proposes that susceptibility to adult disease can be programmed in the womb. An adverse environment in the prenatal and perinatal period can programme the foetus to adiposity later in life. Adverse conditions in country of origin combined with an obesogenic environment may therefore predispose migrant populations to obesity (Murphy *et al.*, 2017).	Thrifty phenotype scenario dependent upon the social and economic conditions in country of origin and the environment of the destination.
Dietary behaviour	Some data suggest that minority ethnic groups have some elements of a healthier diet versus the White British population, e.g. higher fruit and vegetables intake, lower intakes of fat; whilst other data suggest the opposite, and patterns vary widely across minority ethnic groups (Leung & Stanner, 2011).	For migrants, traditional diets are typically healthier than a UK diet, yet traditional diets change via a process of dietary acculturation[4], which has been associated with increased intakes of energy, fat and salt and lower intakes of fruit and vegetables (Leung & Stanner, 2011). Traditional diets are also prone to change, particularly in rapidly developing countries (i.e. the *'nutrition transition[5]'*) (Popkin *et al.*, 2012).	A number of factors are likely to influence the dietary behaviours of minority ethnic groups, such as food availability, food beliefs, cultural identity, and religious dietary laws (Gilbert & Khokhar, 2008; Leung & Stanner, 2011; Osei-Kwasi *et al.*, 2016).

[4] Dietary acculturation refers to the process that occurs when members of a minority group adopt the eating patterns/food choices of the host country (Satia-Abouta, 2010)

[5] The nutrition transition refers to large scale changes in dietary patterns as a result of modernisation, urbanisation, economic development, and increased wealth (Popkin *et al.*, 2012)

Factor	**Ethnicity**	**Migration**	**Influencing factors**
Physical activity	Variation in patterns of physical activity (PA) in ethnic groups are apparent, with children from minority ethnic groups typically showing lower physical activity levels (PAL) than the general population; particularly South Asian groups (Bhatnagar *et al.*, 2015; Gatineau & Mathrani, 2011; Leung & Stanner, 2011; Owen *et al.*, 2010)	There is little comparative research regarding the physical activity of children by migration generation. Migration from to the UK generally comes from countries with higher population PAL than the UK (World Health Organization, 2011). Although adult migrants generally do more PA as a result of occupation and travel, they report more barriers to leisure-time PA (Murphy *et al.*, 2017). On the other hand, research with South Asian adults revealed generational differences in attitudes towards PA, with higher levels in subsequent generations (Bhatnagar *et al.*, 2015).	Cultural and contextual factors that may influence PA habits of minority ethnic groups are wide and varied but include opportunity, values, encouragement, racism (overt and subtle), service delivery, service sensitivity, generation, gender, social acceptance, religious requirements, and ideals related to behaviour and modesty (Bhatnagar *et al.*, 2015; Langøien *et al.*, 2017; Long *et al.*, 2009; Stankov *et al.*, 2012)
Body size preference	Some research has found large body weight preference and low concern for overweight status in some UK South Asian groups, including Bangladeshi (Greenhalgh *et al.*, 1998; Lucas *et al.*, 2013) and some African groups (Trigwell *et al.*, 2014).	Preference for a large body size, especially female, has been observed in migrants from low/middle income countries (Murphy *et al.*, 2017). However, preference for larger body sizes is changing worldwide with a cultural shift in body size beliefs (Toselli *et al.*, 2016)	A commonly proposed explanation for cultural preferences for a large body size is that in places where food availability is low, a larger body size may be symbolic of affluence and health, and preferable for survival and reproduction (Kumanyika *et al.*, 2012)
Socio-economic position	Minority ethnic groups in the UK typically experience higher rates of poverty and lower social status than the majority population, which is likely to contribute to ethnic differences in obesity (Nazroo, 2003). However, deprivation does not appear to fully explain ethnic group differences in children's obesogenic behaviours (Falconer *et al.*, 2014a).	A positive relationship between SES and obesity is apparent in low income countries, which reverses with increasing economic development (Murphy *et al.*, 2017). However, it is likely that social and economic disadvantage experienced by migrants upon arrival in the UK increase obesity risk (Murphy *et al.*, 2017). UK-born ethnic minority groups experience less socioeconomic disadvantage than first generation migrants (Smith *et al.*, 2012).	The role of SEP for migrant groups is likely dependent upon pre-migration socioeconomic status, and there may be preferential migration of those from higher socioeconomic and educational backgrounds due to the resources required for the process.

Factor	Ethnicity	Migration	Influencing factors
Stress	Parental stress has been linked to child obesity, dietary, physical activity and sedentary behaviours (Koch *et al.*, 2008; Parks *et al.*, 2012; Walton *et al.*, 2014; Wilson & Sato, 2014). Ethnicity-related stress can arise from discrimination, stereotyping, and pressure to conform to own ethnic group norms or majority group norms (Contrada *et al.*, 2000).	Migrants are likely to experience some degree of acculturative stress through the process of migrating and adapting to the UK setting. Some evidence suggests that acculturation promotes unhealthy weight gain from men, although results for women were inconsistent (Delavari *et al.*, 2013).	Stress can arise in minority ethnic groups via lower SEP, experiences of marginalisation, social isolation, discrimination and racism (Murphy *et al.*, 2017).

1.3.8 The prevention and management of overweight and obesity

Tackling childhood obesity has been highlighted as a global health priority (Commission on Ending Childhood Obesity, 2015). Approaches for tackling childhood overweight and obesity can be categorised as prevention or treatment strategies, and both of these approaches are seen as crucial in the local management of childhood obesity (Department of Health, 2011). In terms of local delivery, government guidance recommends four tiers in a care pathway for the prevention and treatment of childhood obesity, moving from obesity prevention services (tier 1: universal prevention and tier 2: lifestyle weight management services) to clinical treatment services (tier 3: specialist support and tier 4: surgery) (Robertson *et al.*, 2016). The evidence to-date suggests that for children, school and community settings are an important part of a prevention strategy, whilst family-focused lifestyle interventions that incorporate dietary, physical activity and behavioural components should form the basis of first line treatment policies (Commission on Ending Childhood Obesity, 2015; Mead *et al.*, 2017; Oude Luttikhuis *et al.*, 2009; Waters *et al.*, 2011).

In Cochrane reviews of the effectiveness of interventions for the prevention and treatment of childhood obesity, the authors highlight the areas requiring additional research. For prevention strategies, these include the testing of theory-guided interventions and better reporting and consideration of the impact of the environment, setting and context (Waters *et al.*, 2011). For treatment strategies, research directions include the psychosocial determinants of behaviour change and understanding what interventions are most effective for specific ethnic or religious groups and culturally diverse populations (Mead *et al.*, 2017; Oude Luttikhuis *et al.*, 2009).

Strategies for promoting health can be considered as 'upstream', 'midstream' or 'downstream' depending on their setting, the characteristics of which are outlined in Table 1.6. Researchers are generally in agreement that due to the complexity of the causes of childhood obesity, no single intervention is able to combat obesity alone, and that actions are required at all levels (Commission on Ending Childhood Obesity, 2015). However, there is some evidence from combining the findings of systematic reviews to suggest that downstream approaches may widen socioeconomic public health inequalities (Lorenc *et al.*, 2012).

Table 1.6 Outline of characteristics of upstream, midstream and downstream approaches for obesity (World Health Organization, 2012)

Approach	**Aim / delivery**	**Examples**
Upstream	Aimed at changing the food, physical activity and socioeconomic environments; generally delivered at government policy level	Legislation, workforce development, industry initiatives, urban planning
Midstream	Targeted at populations; tend to consist of psychosocial/behavioural interventions delivered at the community, school or household level	Social marketing, health education
Downstream	Aimed at the individual and tend to consist of health or medically –driven interventions	Health information, 1-1 intervention

Evidence-based approaches are considered essential (Commission on Ending Childhood Obesity, 2015), yet it is understood that the relative effectiveness of these approaches are difficult to assess and compare because of the varying time-scales, measures and intensity of each approach, hence different models of evaluation are required for different types of interventions. Some interventions may not show great effectiveness when assessed in isolation, but can be an important piece of the overall strategy (World Health Organization, 2012).

1.3.8.1 Tailoring of childhood obesity interventions

Interventions to tackle childhood obesity may benefit from being more mindful of community and population -specific factors. It is unclear which components of interventions to tackle childhood obesity are the 'active ingredients' that maximise effectiveness (Waters *et al.*, 2011), and the difficulty in identifying these may be in part due to the variation in population-specific characteristics and contexts, so understanding those specific to local populations should enhance local intervention development (Pallan *et al.*, 2013) and help to improve their relevance and acceptability (Liu *et al.*, 2012). Indeed, NICE guidelines on childhood obesity and behaviour change interventions are clear in emphasising the importance of community engagement and targeting and tailoring of services to best suit the needs of the local community (National Institute for Health and Clinical Excellence, 2007; 2014). There is a consensus amongst researchers in the field of ethnic inequalities in particular that research needs to move towards identifying effective interventions, evaluating the impact of interventions on ethnic inequalities, and defining best practice for the reduction of health inequalities (Mir *et al.*, 2013; Oliver *et al.*, 2008).

Yet a Cochrane review of childhood obesity interventions noted that the majority of research in the field had been conducted with 'motivated, middle-class, Caucasian populations' (Oude Luttikhuis *et al.*, 2009) and there is a lack of evidence on the effectiveness of targeted, tailored health promotion interventions for minority ethnic groups (Liu *et al.*, 2012). A systematic review of obesity interventions for South Asian populations (Brown *et al.*, 2015) found only one culturally adapted intervention delivered for children in the UK (Adab *et al.*, 2014), which has since demonstrated limited effectiveness in tackling childhood obesity in a population with a high proportion of South Asian children (Adab *et al.*, 2018), despite extensive work to ensure relevance (Pallan *et al.*, 2013). Since the review, a further feasibility study is currently underway of an adapted weight management programme for primary school aged children from Pakistani and Bangladeshi communities (Pallan *et al.*, 2016).

The systematic review of Brown *et al.* (2015) also considered evidence from beyond the UK and in adults. The meta-analysis showed an unclear impact of culturally tailored interventions upon outcomes, but the authors identified a number of components of effective interventions with adults that could have applicability in the development of interventions for children (Brown *et al.*, 2015). The authors recommended more research on obesity interventions targeting South Asian children, which report on how they are culturally adapted and the behaviour change mechanisms upon which the intervention is based. In addition, the development of effective interventions will require extensive quantitative and qualitative investigation of attitudes, perceptions and behaviours.

Elsewhere, a recent systematic review of 20 US studies investigating the effects of interventions to prevent obesity in US migrant populations showed positive effects in adult and child interventions which incorporated some cultural focus, although the majority of the included studies were quasi-experimental (Tovar *et al.*, 2014).

1.3.8.2 Theoretical basis of childhood obesity and health promotion interventions

A theoretical underpinning is considered an important element in the design of interventions for tackling childhood obesity (Craig *et al.*, 2008), and there is a need for more research on the application and effectiveness of interventions with a theoretical basis (Waters *et al.*, 2011). There are a number of theories that can support the design of culturally tailored childhood obesity interventions at various stages of development – from identification of the problem (or determinants) to specific intervention components. Table 1.7 outlines those that have informed elements of this research.

Table 1.7 Outline of theories and frameworks relevant to childhood obesity and the cultural tailoring of interventions

Theory	Relevance	Examples of use	Use within thesis
Socioecological model (Davison & Birch, 2001; Harrison *et al.*, 2011b)	**For identifying the determinants of childhood obesity.** Outlines the multiple and interacting levels of influence upon the development of childhood obesity using a systems approach. Spheres of influence exist at the biological level ('cell'), individual level ('child'), family level ('clan'), community level, country level and cultural / societal level.	• Zilanawala *et al.* (2015) used the model to explore observed ethnic disparities in overweight and obesity at 5 years of age, but were only able to study a small number of variables (some socio-demographic, cultural and family routine factors) from the model due to the scope of the study.	Conceptual guide for: • Organising systematic review findings (chapter 2) • Theorising levels of influence for multilevel model (chapter 3) • Designing topic guides (chpaters 4 and 5) • Informing coding framework during anaylsis (chapters 4 and 5) • Considering implications of study findings for policy and practice (chapter 7)
Community Energy Balance (Kumanyika *et al.*, 2012)	**For contextualising cultural influences upon obesity in ethnic minority populations** Supports the design of interventions that consider the influence of culture and context upon obesity, particularly those that differentiate ethnic minority populations from their respective reference populations.	• The authors encourage research that reflects on framework elements from the perspectives of specific minority ethnic populations • Used by Sawyer *et al.* (2018) to operationalise the multifaceted effects of sociocultural constructs on neighbourhood-based physical activity.	• Provided support for hypothesising the influence of culture and context upon health behaviours (chapters 5 and 6) • Conceptual guide for considering implications of study findings for policy and practice (chapter 7)

1.3.9 Limitations in current literature

This literature review has highlighted a number of gaps in the literature in relation to the role of ethnicity in childhood obesity:

1. Which ethnic groups are at high risk for overweight and obesity in the UK?
2. How appropriate is the use of BMI, existing thresholds and existing reference populations in identifying childhood overweight and obesity across all ethnic groups?
3. What is the role of socioeconomic position in the relationship between ethnicity and overweight and obesity?
4. How do cultural and contextual factors differ across ethnic groups within the UK and to what extent they can explain differences in overweight and obesity prevalence?
5. What role do neighbourhood and environmental factors play in relationship between ethnicity and overweight and obesity?
6. What are the dietary, physical activity and sedentary behaviours of children and families from minority ethnic groups and what are the factors that influence these behaviours?
7. What are the views of children on obesity-related behaviours, particularly the view of children from minority ethnic groups and lower socioeconomic groups?
8. How well do existing ecological systems models of obesity conceptualise the determinants of childhood obesity for those from minority ethnic groups?
9. What is the relative strength and importance of the influencing factors, and their interactions, within models of childhood obesity for those from minority ethnic groups?
10. How can interventions acknowledge the impact of the environment, setting and context in their design?
11. What are the local population-specific characteristics and contexts, and how does an understanding of these enhance local intervention development?

1.3.10 Conclusions

This literature review highlighted the lack of consensus on the presence and nature of ethnic inequalities in childhood obesity, particularly at a local level, as well as the role of associated factors such as socioeconomic position. In particular, there is a need to explore the potential variation in obesogenic dietary, physical activity and sedentary behaviours of children, and the community-specific cultural and contextual factors that influence these patterns e.g. environmental, lifestyle and cultural factors, from the perspectives of children and their parents. Finally, when exploring ethnicity and socioeconomic position as variables in health, the findings should be applied to the planning of health services aimed at reducing existing inequalities in health, yet very few tailored interventions have been empirically tested in the UK. Ultimately, the factors contributing to childhood obesity form a highly complex system, and any research investigating these determinants, and the potential strategies for tackling them, needs to consider how individual behavioural determinants arise within complex ecological contexts.

1.4 The research setting: a profile of Coventry

The setting for this research was Coventry, a very ethnically diverse population and opportune location for exploring this topic. This section provides an overview of the population of Coventry.

1.4.1 Population description

Coventry is the ninth largest city in England (Office for National Statistics, 2016b), and as such the population is characterised by many features typical to large cities, with high ethnic diversity and high deprivation compared to averages for the West Midlands region and England (see Table 1.8 for total population and Table 1.9 for child population) (Office for National Statistics, 2016b).

Table 1.8 Characteristics of the Coventry population

Whole population	**N**	**%**	**Source**
Population (adults and children)	345,385		
Ethnic groups	**316,960**		Office for National Statistics (2015)
White British	211,188	66.6	
White Irish	7305	2.3	
White Gypsy or Irish Traveller	151	0.05	
White Other White	15,385	4.9	
Mixed White and Black Caribbean	3672	1.2	
Mixed White and Black African	943	0.3	
Mixed White and Asian	2388	0.8	
Mixed Other	1227	0.4	
Asian/Asian British: Indian	27,751	8.8	
Asian/Asian British: Pakistani	9510	3.0	
Asian/Asian British: Bangladeshi	2951	0.9	
Asian/Asian British: Other Asian	7658	2.4	
Black African	12,836	4.0	
Black Caribbean	3317	1.0	
Other Black	1611	0.5	
Chinese	3728	1.2	
Any other ethnic group	5339	1.7	
Country of birth	**316,960**		Office for National Statistics (2015)
Non-UK born	67,233	21.2	
Main language spoken (aged >3)	**303,130**		Office for National Statistics (2015)
English	261,117	86.1	
Panjabi	6849	2.3	
Polish	6161	2.0	
Gujarati	2523	0.8	
Urdu	2479	0.8	
Deprivation			
% of residents living in neighbourhoods amongst the 10% most deprived in England		18.5%	Department for Communities and Local Government (2015)

Table 1.9 Characteristics of the Coventry child population

Population (children only)	n	%	Source
Aged 0 - 18 years	79,577	23.0	
Aged 4 - 11 years	34,678	10.0	
Ethnic group (n = 25,050, children of compulsory school age attending state funded primary schools only)	25,050		National Statistics (2016)
White British	12,745	50.9	
White Irish	93	0.4	
White Gypsy or Irish Traveller	286	1.1	
White Other White	1845	7.4	
Mixed White and Black Caribbean	568	2.3	
Mixed White and Black African	222	0.9	
Mixed White and Asian	410	1.6	
Mixed Other	485	1.9	
Asian/Asian British: Indian	1939	7.7	
Asian/Asian British: Pakistani	1344	5.4	
Asian/Asian British: Bangladeshi	436	1.7	
Asian/Asian British: Other Asian	1019	4.1	
Black African	2569	10.3	
Black Caribbean	195	0.8	
Other Black	234	0.9	
Chinese	123	0.5	
Any other ethnic group	423	1.7	
Not stated/not obtained	114	0.5	
Main language spoken (n = 25,062, children of compulsory school age attending state funded primary schools only)			
Number of pupils with English as a second language	8290	33.1	National Statistics (2016)
Deprivation			
Number of pupils eligible for and claiming free school meals (n = 32,533, full and part-time children attending state funded primary schools)	5819	17.9	National Statistics (2016)
% of Children in low-income families (income <60 per cent of the median income)		25.1	HM Revenue and Customs (2015)

1.4.1.1 Ethnicity

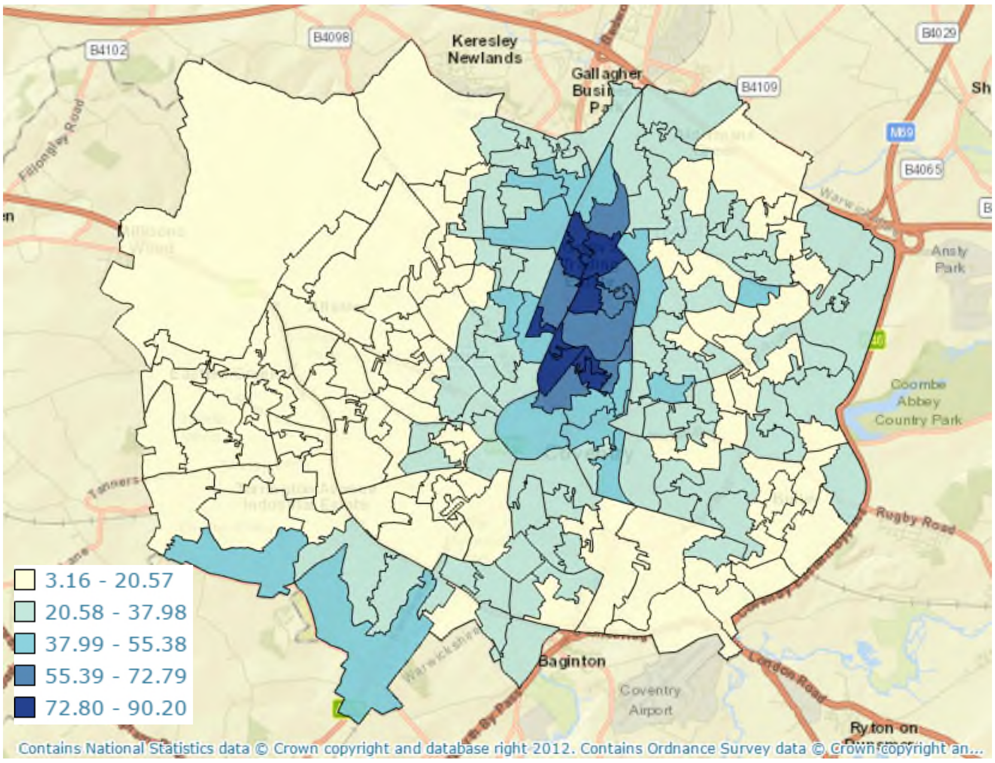
South Asian, Irish and Black Caribbean communities are well established in Coventry, with the largest migrations having arrived largely in the 1950s and 60s in these groups. Migration continues to contribute to a dynamic population in Coventry, and the city has experienced the largest amount of net migration outside of London (Mavrodaris, 2014). In recent years, migration to Coventry has originated from Afghanistan, Iraq and Africa and from the new accession states in the European Union (Mavrodaris, 2014). The birth rate in Coventry has increased from 2001-2011, with the majority of the increase attributable to births among non-

UK-born mothers (Mavrodaris, 2014), contributing to an increasingly diverse childhood population, with 49.1% of school children from minority ethnic backgrounds (National Statistics, 2016).

In the childhood population, Asian / Asian British is the largest minority ethnic group, with 18.9% of children from Bangladeshi, Indian, Pakistani or other Asian ethnic backgrounds. There are also many children from Black / Black British, White other and mixed backgrounds. This includes children born outside the UK (migrants), those born in the UK to non-UK-born parents (second generation) and those born in the UK to UK-born parents (generally third generation or beyond).

33.1% of school children have English as a second language, with Punjabi, Urdu and Polish the most commonly spoken first languages in children after English (National Statistics, 2016). Across the Coventry population of adults and children, 21.2% were born outside of England and 3.1% report not speaking English or not speaking it well (Coventry City Council, 2016a). Christianity is the most commonly reported religion in Coventry (53.7%), and there is also a substantial proportion of Muslim (7.5%), Sikh (5%) and Hindu (3.5%) residents (Coventry City Council, 2015).

Figure 1.5 Map of the distribution of minority ethnic groups (as % of residents of non-White British ethnicity) in Coventry (Coventry City Council, 2016c)



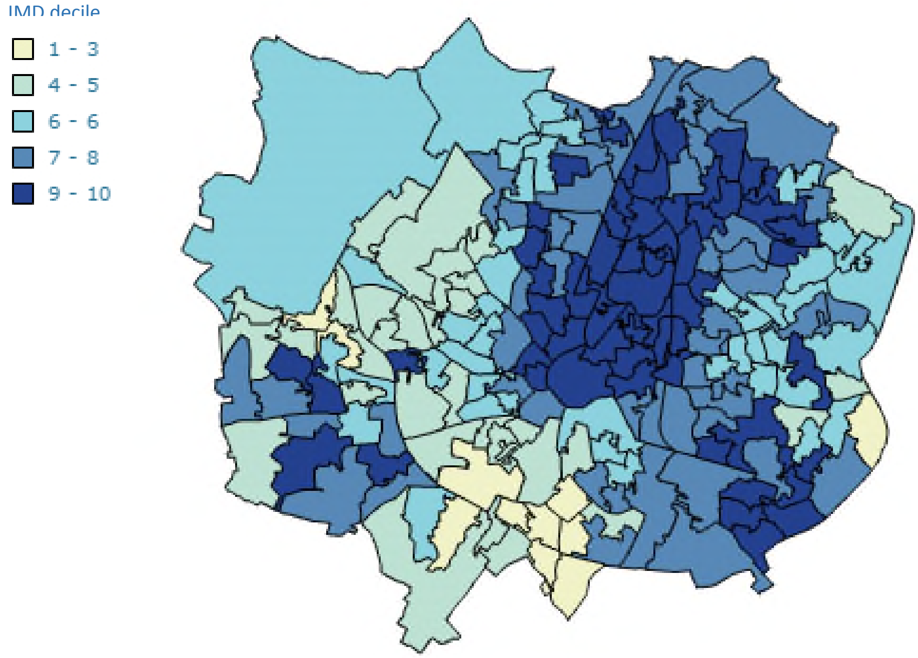
Although Coventry residents from minority ethnic groups are geographically spread across the whole city, Figure 1.5 shows the highest concentrations of residents of non-White British ethnicity are around the city centre and north east, including Foleshill, St Michael's, Radford, Stoke electoral wards (Coventry City Council, 2016c). These wards correspondingly have some of the lowest life expectancies in the city (Coventry Health and Wellbeing, 2016).

1.4.1.2 Deprivation

Over a fifth of children live in low income families whilst 18.5% of Coventry residents live in wards considered to be in the highest deprivation decile for England, both figures for which are higher than the West Midlands and England levels (Coventry City Council, 2016a). Average annual disposable household income is amongst the lowest in England with averages at £13,397 (Office for National Statistics, 2016a).

There are pockets of deprivation throughout Coventry, although as shown in Figure 1.6, the geographical spread appears to be central and eastwards (Public Health England, 2014).

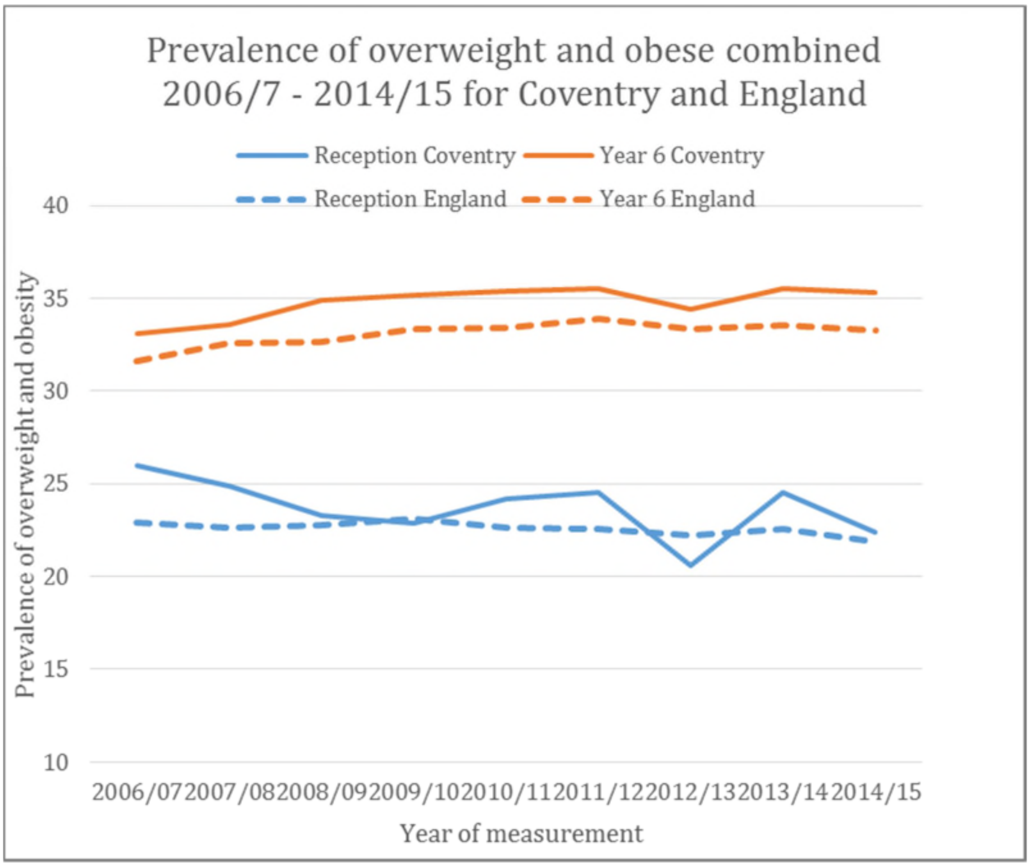
Figure 1.6 Map of Coventry LSOAs categorised by their IMD 2010 decile (Coventry City Council, 2016b)



1.4.2 Childhood Obesity in Coventry

In Coventry, the prevalence of overweight and obesity was estimated to be 22.4% (95% confidence intervals (CIs): 21.2 – 23.7%) in 4-5 year old children and 35.3% (95% CIs: 33.8 – 36.9%) in 10-11 year old children in 2014/15, which is higher than the national average of 21.9% (95% CIs: 21.8 – 22.0%) and 33.2% (95% CIs: 33.1 – 33.4%) respectively (Health and Social Care Information Centre, 2015b). For year 6 children in particular, overweight and obesity was statistically higher than national levels, based on non-overlapping confidence intervals, indicating a need to address childhood obesity locally. Trends mirror those at a national level, with a small decline in reception year over the period and a small increase in year 6 children, although there is more variation in Coventry rates which is likely to be the effect of a smaller sample base (Figure 1.7).

Figure 1.7 Prevalence of overweight and obese combined 2006/7 - 2014/15 for Coventry and England (Health and Social Care Information Centre, 2015b)



1.4.2.1 Policy context in Coventry

In December 2016, the Director for Public Health's Annual Report focused on promoting healthy weight among children and young people, calling for a 'step change' in the way obesity is tackled in the city (Coventry City Council, 2016d). Although addressing *ethnic* inequalities was not explicitly mentioned in the report, there was a clear focus on reducing health inequalities and prioritising families with the greatest need. In keeping national strategic directions discussed in section 1.3.3.1, the report also laid out its vision to build the capacity of local communities to promote healthy choices and build local partnerships.

Aims included developing the local evidence base and working with universities to ensure local agencies are making best use of evidence. As part of the launch of the report, a local Obesity Alliance was formed, bringing together those working directly or indirectly to promote healthy weight with the aim of identifying a system, developing relationships, engagement and communication, and building capacity, creativity and innovation.

In addition, Coventry was one of seven cities in the UK which was invited to participate in the UK Marmot Network and become a Marmot city, a strategic initiative that brought together multiple agencies (Coventry City Council, NHS Coventry and Rugby Clinical Commissioning Group, West Midlands Police, West Midlands Fire Service and Voluntary Action Coventry) and provided access to the expertise of the Health Equity Unit at University College London (Coventry City Council, 2018). This further highlights Coventry's commitment to reducing health inequalities. Initial reports suggest this strategic prioritisation of health inequalities has had some success (Faherty & Gaulton, 2016), however the strategic direction again focuses on socioeconomic inequalities.

Given that population growth in Coventry is largely a result of international migration to the city, migrant health was a specific focus of a health needs assessment in Coventry (Mavrodaris, 2014), and also featured in the 2016 Joint Strategic Needs Assessment (Coventry Health and Wellbeing, 2016). In addition, a joint report by multiple agencies in Coventry identified that the health and well-being of women from Black and Minority Ethnic (BME) groups in Coventry would be disproportionally disadvantaged by cuts of public funding (Sandhu *et al.*, 2013).

Of particular relevance to this research project, the Migrant Health Needs Assessment identified lower consumption of five or more portions of fruit and vegetables per day for residents from Indian and Pakistani ethnic groups and lower levels of physical activity for South Asian children (Mavrodaris, 2014). Diabetes in Asian groups and hypertension in African groups were highlighted as major primary care concerns in adults, two diseases for which obesity is a direct risk factor. The authors recommended improved access to public health programmes for migrant groups, improving the cultural competency of staff, addressing cultural and language differences in the design of services, and use of community-led solutions.

1.4.2.2 Obesity services

Although local analysis of NCMP data has revealed variation in overweight and obesity across deprivation levels, and in ethnic groups using aggregated ethnic groupings (Harrell, 2010), there has been no formal analysis locally of ethnic variation in childhood overweight and obesity, particularly using disaggregated ethnic groupings. The West Midlands CLAHRC also highlighted a need to explore the determinants of childhood overweight and obesity in the diverse population of Coventry, in order to contribute towards identifying appropriate approaches for tackling childhood overweight and obesity.

Coventry's key obesity service is One Body One Life (OBOL), delivered by the *Be Active, Be Healthy, Be Happy* team, and is a 10 week family programme consisting of healthy eating, physical activity and behaviour change elements. Attending families should have one or more member of the family with an 'unhealthy weight' (underweight, overweight, or obese). A service evaluation revealed significant improvements in children and adults' knowledge of healthy eating and physical activity, and significant improvements in children's BMI percentile, body fat percentage, waist circumference and heart rate, although numbers were small (n = 272 children) with a high proportion of missing data for some measures (for example, n = 54 for child BMI), and there was no control group with which to make comparisons (Towey *et al.*, 2011). However, turnout from children and adults from deprived areas and from non-

White groups was relatively high, although retention was significantly lower for children from mixed ethnic backgrounds compared to other ethnic backgrounds (Towey *et al.*, 2011).

In addition, a randomised controlled trial was conducted from 2012 to 2014 with Coventry as a study site to investigate the effectiveness of a childhood weight management intervention 'Families for Health' (FFH) versus usual care (OBOL) (Robertson *et al.*, 2017). FFH was a 10-week community-based family programme addressing parenting, lifestyle change and social and emotional development. However, the trial found no significant difference in BMI z-score at 12 month follow-up between FFH and OBOL participants, despite higher costs of FFH compared to usual care. However, it is important to note that usual care in Coventry (OBOL) was a similar family-based lifestyle programme, so it is perhaps unsurprising that there was little difference between the two arms.

Both of these programmes were not explicitly targeted nor tailored for minority ethnic groups, and neither incorporated a cultural focus to maximise relevance for the diverse child population of Coventry.

1.5 Methodology and rationale

1.5.1 Research questions

The aim of this thesis was to explore the factors influencing risk of childhood overweight and obesity in Coventry, with a particular focus on ethnicity and associated factors such as socioeconomic position. The broad research questions underpinning this research were as follows:

1. What are the factors associated with childhood overweight and obesity in minority ethnic groups in the UK**?**
2. Is there variation in childhood weight status across ethnic groups in Coventry?
3. What are the cultural[6] and contextual[7] factors that influence childhood overweight and obesity in Coventry?
4. To what extent does a mixed methods approach improve understanding of childhood overweight and obesity across ethnic groups in Coventry?
5. Should ethnic background be considered for the design and delivery of childhood obesity prevention and treatment services in Coventry?
6. How relevant are existing ecological systems models for explaining childhood obesity in minority ethnic groups?

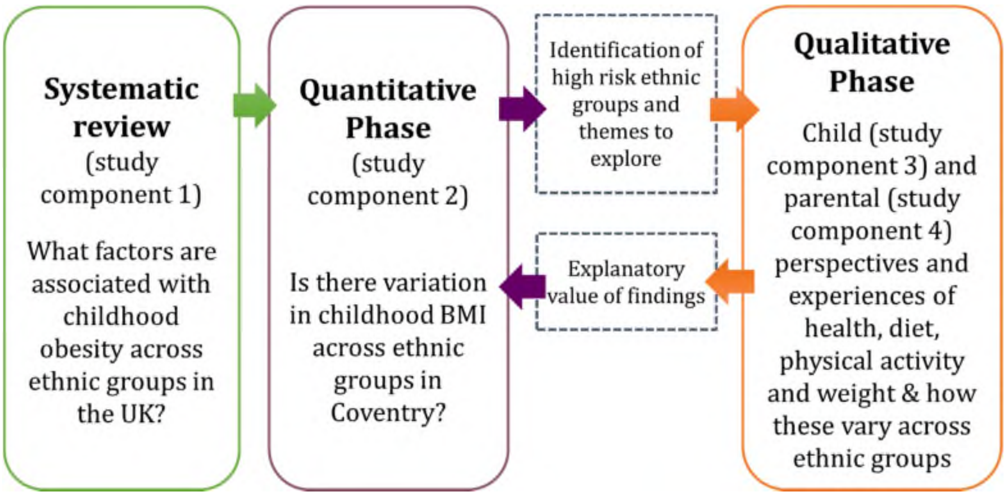
1.5.2 Research approach

A mixed methods approach was considered to best suit this research problem. An explanatory sequential design with multiple types of integration was used (Curry & Nunez-Smith, 2015), with quantitative data analysed first, followed by in-depth qualitative investigation, as outlined in Figure 1.8. Preliminary research consisted of a systematic review of the factors associated with childhood obesity across ethnic

[6] Culture refers to *"a dynamic system of meaning, knowledge and actions that provides actors collectively , interpersonally, and individually with community-legitimized strategies to construct, reflect upon and reconstruct their world and experience, and guide behaviour"* (Nastasi *et al.*, 2015 p.96)
[7] Context refers to a specific setting or set of circumstances (Nastasi & Hitchcock, 2016)

groups in the UK (study component 1). Secondary analysis of existing child measurement data was used to investigate the influence of a number of factors upon childhood overweight and obesity, to help understand which ethnic groups are most at risk (study component 2). Through connected integration, the quantitative data were used to inform the sampling and design of the qualitative phase. The qualitative phase consisted of focus groups and interviews with children (study component 3) and parents (study component 4) to better understand community-specific cultural and contextual factors that contribute to overweight and obesity. Through merged integration, these findings were used to help explain the quantitative findings.

Figure 1.8 The explanatory sequential mixed methods design for the purpose of exploring childhood obesity in Coventry



1.5.2.1 Rationale for approach

Johnson *et al.* (2007) propose the following definition for mixed methods research:

> "[Mixed methods] combines elements of qualitative and quantitative research approaches for the broad purposes of breadth and depth of understanding and corroboration" (p.123).

Mixed methods has been discussed as a valuable approach to research in the health sciences, due to its ability to research multifaceted phenomena and its pragmatic nature (Curry & Nunez-Smith, 2015). Nastasi and Hitchcock (2016) also propose mixed methods as the ideal approach for understanding contextual and cultural influences in programme planning. These two viewpoints form the basis for the use of mixed methods in the current project.

First and foremost, the rationale for the use of mixed methods in the current study was one of pragmatism, guided by the research questions. For example, a quantitative approach was considered necessary for understanding variation in childhood overweight across ethnic groups, whilst a qualitative approach was required for exploring perspectives and experiences of children and parents. These questions could have been answered via standalone studies, however the mixing of these two methods was deliberate in order to provide added value: the quantitative study component was used to guide the sampling and data collection of the qualitative methods (a 'development' rationale, as defined by Greene *et al.* (1989)), and in turn the qualitative study components were included to provide some depth and explanatory value to the quantitative findings (an 'expansion' rationale, as defined by Greene *et al.* (1989)). Qualitative methods in particular were thought to offer more scope for analysis of the multi-dimensionality of ethnicity as a variable in a study population, typically not available in the categorical analyses of quantitative research, and in understanding the ways in which context and culture (e.g. social norms, beliefs and values) influence childhood obesity (Nastasi & Hitchcock, 2016).

It is the integration of these study components that make this a 'mixed methods' approach as opposed to a 'multi-method' approach (Barbour, 1999; Curry & Nunez-Smith, 2015). As such, the aim of mixed methods in this study was to produce knowledge unavailable to the standalone approaches: through an improved qualitative study component (i.e.

through enabling purposive sampling and guiding data collection); an engagement with the complexity of obesity as an issue (i.e. exploring the issue from multiple perspectives); and the creation of 'a wider picture' (i.e. providing depth in our understanding of the quantitative findings) (O'Cathain & Thomas, 2006).

1.5.2.2 Challenges in mixed methods research

One challenge in mixed methods research is the integration of *'quantitative'* and *'qualitative'* epistemologies, which have traditionally been seen as two distinct disciplines within health research (*'positivist'* versus *'interpretivist'*, and *'deductive'* versus *'inductive'* respectively). However, most mixed methods researchers now consider such 'paradigm wars' as a distraction, and instead focus on the ability of methods to answer the research question at hand (Curry & Nunez-Smith, 2015). Creswell and Plano Clark (2011) also claim that as a pragmatic type of research, it is possible for mixed methods researchers to embrace multiple worldviews.

The strength and rigour of the chosen methods, regardless of epistemological grounding, remain of the highest importance (Curry & Nunez-Smith, 2015). This research therefore considers the scientific rigour of individual study components (addressed in each chapter), before attempting to understand the trustworthiness of the final mixed methods integrated findings. For quantitative methods, the constructs of validity and reliability are well established, however there is less consensus for corresponding quality constructs in qualitative research. O'Reilly and Kiyimba (2015) amalgamate a number of approaches to assessing quality in qualitative research, and their constructs of transparency, reflexivity, transferability, ethicality and integrity were used for the two qualitative study components in the current study. However, Curry and Nunez-Smith (2015) propose an additional level of quality appraisal to ensure a high-standard mixed methods study, and outline a mixed methods appraisal framework by which to do this, which will be considered in the final discussion chapter in way of summarising the strengths and limitations of the overall *mixed methods* study.

1.5.2.3 Additional considerations for qualitative research

As outlined by Greene and Thorogood (2014), a true qualitative approach is underpinned by some broad orientations which were incorporated into the qualitative components of this research: 1) a commitment to naturalism i.e. to understand health behaviours within the context of participants' daily lives, in their own environment, using their own words; 2) adoption of reflexivity to comprehend the research topic as it sits within a broad political and social context, and how the researcher's experiences contribute to the interpretation of the data generated; 3) an empathetic approach that focuses on meaning and understanding (that there are reasons for why people behave the way they do); and 4) flexibility, to allow for a shifting of perspective or unexpected opportunities.

These values underpinned the design of the qualitative elements, for example, the use of participant-centred methods (to support naturalistic inquiry and an empathetic approach); reflexive statements within each qualitative study component (to support reflexivity); and an iterative, adaptable approach (to support flexibility). More consideration of the qualitative approaches used in this research are provided in Chapters 4 and 5.

1.5.2.4 Identification and categorisation of ethnicity

This research centres arounds concepts of ethnicity, migration, culture and ethnic identity. As detailed in the literature review, it is important to use appropriate measures of ethnicity, and describe how ethnic categories have been derived (Bhopal, 2014; Burton *et al.*, 2010; Mathur *et al.*, 2013). In the current research, different methods were used to capture ethnic identity, as was in keeping with the particular mode of research, and more detail is provided in Table 1.10. The limitations of ethnic categories are discussed critically in each chapter.

Table 1.10 Description of identification and categorisation of ethnicity in the current research

Study component	Identification	Categorisation
Study component 1: Systematic review	Varied according to methods used in included studies	Varied according to methods used in included studies
Study component 2: Analysis of quantitative data	Parental self-report	Census categories
Study component 3: Qualitative study 1	Parental self-report	Census categories
Study component 4: Qualitative study 2	Participant self-report	Two methods used: census categories (in screening questionnaire) and a self-description using a free text box

1.5.2.4.1 Reflection on ethnic identity

Of additional importance when researching ethnicity is for the researcher to recognise the potential influence of their personal values upon the research (Bhopal, 2014; Burton *et al.*, 2010; Mathur *et al.*, 2013). Bhopal (2014) encourages health researchers to reflect on the complexity of defining ethnicity and race by contemplating their own self-descriptions. This approach also suits the qualitative concept of reflexivity and transparency, through describing and acknowledging the potential for researcher characteristics to influence the nature of the research. Below, a statement of ethnic and racial identity is provided, based on the self-reflection questions posed by Bhopal (2014):

> I am born in Britain and am classified by the census definition as 'White'. I have rarely considered my 'race' and am becoming increasingly aware that this lack of consideration is a result of the certain privileges granted to me as a 'White' person (i.e. it has not been an issue for me because I do not feel as though I have been discriminated against on the basis of my race).

I have given much more thought to my ethnicity, although in the past I have considered this my 'cultural' rather than 'ethnic' identity. Both of my parents are Irish-born and Catholic, and this forms the basis for much of my cultural heritage. My own ethnic identity has fluctuated from Irish (as a child) to British (as a young adult), and remains dynamic. In more recent years, and largely as a result of undertaking this research, I have become more reflective about my ethnicity, and now I would consider myself in the self-appointed category of 'British Irish', although I have never used this description on official documentation (having never opted for the 'White other' category).

Personally, I feel both my Irish and British backgrounds have contributed equally but separately to my cultural values, and feel it is especially important in current times to acknowledge my 'second generation' migratory background.

1.5.2.5 Theoretical foundations

The theoretical foundations of this study were two existing models, as outlined in section 1.3.8.2. These foundations were used to collate the existing literature in study component 1 (systematic review) and as a framework for the analysis and interpretation of data (study components 2, 3 and 4). In particular, the SEM, based on EST (Bronfenbrenner & Morris, 2006), forms the conceptual basis of discussions in a number of chapters. Within childhood obesity, a number of SEMs have been produced, using a variety of different terms to describe levels of influence. For the purposes of this study, these models and their terms have been amalgamated in Table 1.11, matched to corresponding levels with the EST proposed by (Bronfenbrenner, 1979), with a short summary of example components.

Table 1.11 Socioecological levels of influence used throughout the thesis

EST levels	SEM levels	Examples
n/a	Biological level ('cell')	Genetics, physiology, anthropometry, *in-utero* environment
Microsystem and exosystem	Individual level ('child')	Age, gender, ethnicity, knowledge, beliefs, preferences, dietary, physical activity and sedentary behaviours
	Family level ('clan')	Socioeconomic position, resources, family ethnicity, family size, parental educational level; parenting practices
	Community level	Peers, school, neighbourhood, built environment, local services, issues of physical access/availability, perceptions of environment
Macrosystem	Country level	Political, economic, societal, social, and organisational factors; media and marketing
	Cultural level	Cultural norms and beliefs, gender norms, religious beliefs
Mesosystem	Connections and interactions between levels	e.g. interactions between child and family
Chronosystem	Time	Changes over life course, generations, and society at large

1.5.3 Research governance and funding statement

This PhD was funded through the NIHR CLAHRC West Midlands. Use of the NCMP data set was permitted through a data processing agreement with Coventry City Council. Ethics approval was granted by the University of Warwick Biomedical Sciences Research Ethics Committee as follows: REGO-2015-1368 (March 2015); REGO-2016-1760 (March 2016) and REGO-2016-1760-AM01 (March 2017).

1.6 Chapter summary

This chapter aimed to set the scene for the thesis, outlining the need to explore childhood obesity, and the complexity of its determinants and prevention and management, and introducing the key concepts of ethnicity, socioeconomic position, culture and context. The chapter outlines the gaps in the literature upon which the research questions were constructed, which are addressed through the four study components that form the basis of this thesis (Chapters 2-5). A rationale is provided for the use of a formative, mixed methods study design, and the merging of these mixed methods is reported in Chapter 6, and reflected upon in Chapter 7.

Chapter 2 A systematic review of the factors associated with adiposity in children aged 4 – 11 years from minority ethnic groups in the UK

2.1 Chapter outline

This chapter reports on a systematic review of the literature investigating factors associated with childhood overweight and obesity in minority ethnic groups in the UK, in order to aid understanding of how individual, cultural and contextual factors contribute to overweight and obesity prevalence across ethnic groups (study component 1). The findings of the review were used to guide the proceeding elements of the research, by highlighting areas that required further exploration through quantitative and qualitative methods.

2.2 Background

Although the nature of ethnic differences in overweight and obesity prevalence is still under investigation, the evidence regarding the determinants that give rise to these differences is even less well established. A systematic review by El-Sayed *et al.* (2011) identified only one paper exploring the determinants of obesity by ethnic group, which was limited to parental anthropometry and socioeconomic status (Rona & Chinn, 1987), despite the complexity of the issue.

2.3 Study aims

The aim of this chapter was understand the factors associated with childhood overweight and obesity in minority ethnic groups in the UK**.**

A systematic review of the literature was conducted with two objectives:

1. To identify the factors that influence overweight and obesity in children aged 4 – 11 years (primary school age) from minority ethnic groups within the UK.
2. To review the evidence-base with consideration of the quality of the evidence and the limitations in the existing literature.

2.4 Methods

The protocol for this systematic review is reported on the PROSPERO International prospective register of systematic reviews under reference number PROSPERO 2015 CRD42015019239.

2.4.1 Search strategy

After seeking advice from an experienced librarian, broad search terms and subject headings were devised combining the themes of ethnicity and migration; overweight and obesity; and primary school aged children (Table 2.1.), with limits applied for age (<12 years) to identify relevant studies across seven databases (Medline, Embase, CINAHL, Psychinfo, ASSIA, Web of Science and CSA Sociological Abstracts) up to 13th May 2015. No date or language limits were applied and no search terms relating to country were used to avoid limiting the search sensitivity. In addition, the reference lists of relevant systematic reviews and included articles were scanned, papers citing included articles were screened, the journal Ethnicity and Health was hand-searched and the thesis database EThOS was searched to identify further articles and theses. The strategy aimed to maximise search sensitivity so terms were intentionally broad.

Table 2.1. Themes, inclusion criteria and search strategy

Theme	**Inclusion criteria**	**Subject headings and keywords**
Overweight and obesity	Used an objective measure of adiposity as an outcome	"Pediatric Obesity"[1] Overweight or obes*[2]
Ethnicity and migration	Study sample was a specific minority ethnic group or migrant group; or analysis stratified by ethnic group or migrant status ('minority ethnic group' was defined as those other than White British)	"Ethnic Groups" Ethnic* "Emigrants and Immigrants" Migration or migrant*
Age	Study sample included children within age range 4 – 11 years	Child* Limit: Child, Preschool: 2-5 Limit: Child: 6-12 years
UK	Conducted in the United Kingdom, Great Britain, England, Wales, Scotland or Northern Ireland	None applied

[1] Terms in inverted commas denote MeSH terms
[2] Asterisk denotes truncation

2.4.2 Selection

Titles and abstracts were screened in the first instance by two independent reviewers (MM and JP), to maximise the inclusion of all eligible articles, with studies excluded only if both authors agreed that the inclusion criteria had not been met. Full texts were located for the second phase of screening, with each full text screened by two independent reviewers (MM, WR, RJ and FB). Disagreements about inclusion and exclusion were initially discussed between the two reviewers, and resolved by a third reviewer if necessary. Cohen's kappa was used to assess inter-rater reliability (Landis & Koch, 1977).

Studies were included if they explored the relationships between an explanatory factor(s) and objectively measured childhood adiposity; in a specific minority ethnic group / migrant group, or with analysis stratified by ethnic group / migrant status; and a study sample of children aged between 4 – 11 years living in the UK. Studies were excluded if conducted in a purely clinical population e.g. diabetic; hypertensive; asthmatic; did not report on primary school aged children and adolescents separately; did not conduct either primary or secondary data analysis e.g. was an editorial or position paper; were systematic reviews or meta-analyses.

2.4.3 Data extraction and quality assessment

A data extraction tool was piloted prior to use, with five papers randomly selected to undergo double data extraction, each carried out by two reviewers (MM, WR, RJ and FB) to ensure accuracy and completeness of the tool. Two quality assessment tools were considered including the Newcastle-Ottawa scale (Wells *et al.*, 2018) and the National Institute for Health (2016) tool, to test for risk of bias in the included studies. After piloting, the 14 item Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies designed by the National Institute for Health (2016), was selected for relevance and ease of use. This tool assesses quality based on the description of the research question, study population, recruitment, sample size, timing of exposure and outcome measures, timeframe, exposure measures and assessment, outcome measures and assessment, blinding, follow-up rate and statistical analyses. Based on the assessment of each of these study design elements, a quality rating of good, fair or poor is decided. Five papers were randomly selected to undergo double quality assessment, each carried out by two reviewers (MM, WR, RJ and FB).

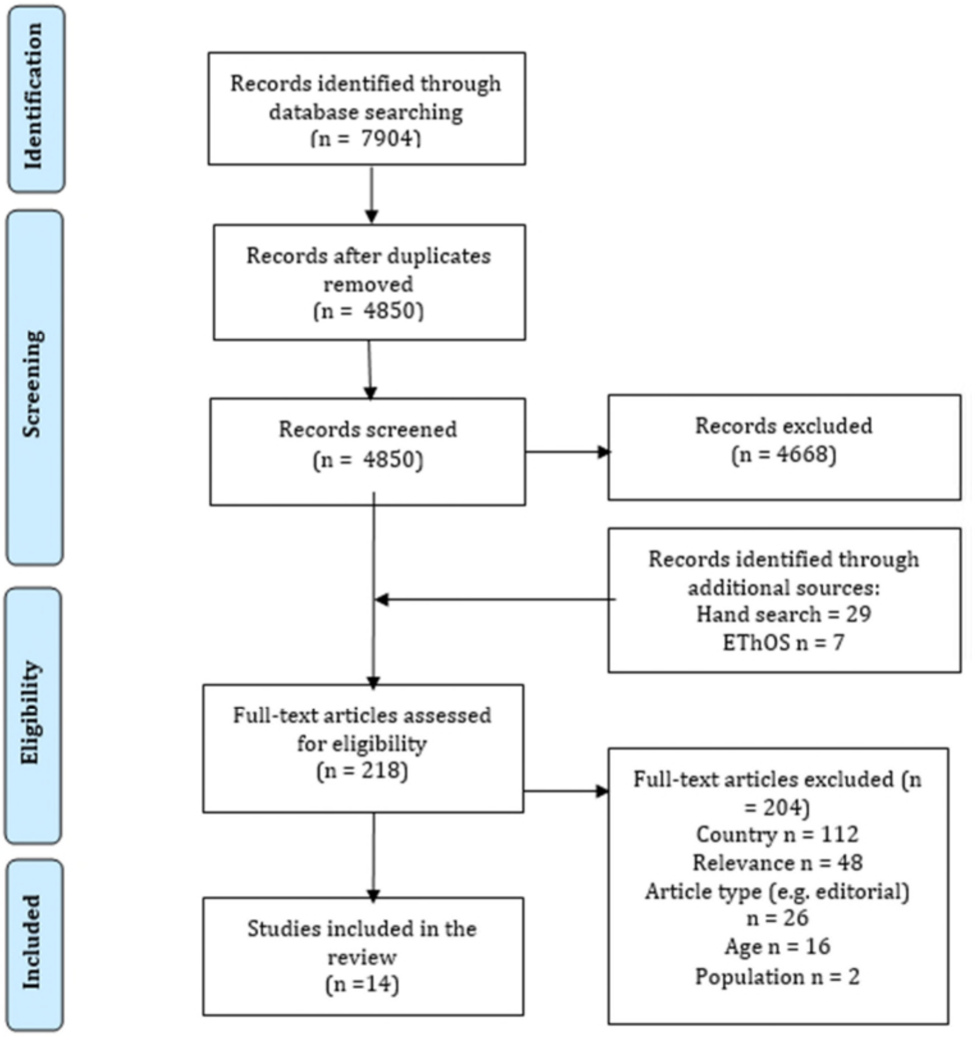
2.4.4 Synthesis

A meta-analysis was not possible due to the heterogeneity in variables used across the studies, therefore a narrative synthesis of the results was conducted. Following guidance by Popay *et al.* (2006), this first involved developing a preliminary synthesis through textual descriptions of each study and grouping of exploratory variables into an analytical framework based on a socioecological model of health (Harrison *et al.*, 2011b; Sallis *et al.*, 2008). Counts were used to identify the frequency with which variables had been explored in the included literature. Tabulation was used to identify relationships common in the whole sample and those specific to broad ethnic groupings (White; Black; Asian; other) for each study. The table was then summarised for presentation in the results section. The quality assessment of studies was utilised to explore relationships between findings and study characteristics, adding information about study-type, metrics used, ethnic groupings and quality ratings. Finally, a summary table was produced and robustness of the synthesis was assessed through consideration of the weight of the evidence and critical reflection on the synthesis process.

2.5 Results

Figure 2.1 illustrates the number of papers identified, screened, excluded and included, based on the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines (Moher *et al.*, 2009). A total of 7904 records were identified through the database searches. Following de-duplication, the titles and abstracts of 4850 articles were screened with a Cohen's kappa showing 97% agreement between two researchers, with a κ=0.34, indicating fair agreement. An additional 36 articles were located through additional sources (hand searching and EThOS). Full texts were located for 218 papers for the second phase of screening, with a Cohen's kappa calculated prior to discussion of disagreements and showing 89% agreement with a κ=0.59, indicating moderate agreement. Ten articles out of 218 were sent to a third reviewer for arbitration. 14 articles were deemed to have met the inclusion criteria.

Figure 2.1 PRISMA diagram for systematic review



2.5.1 Description of included studies

The included studies are detailed in Table 2.2. Six studies reported on analyses from the Millennium Cohort Study (MCS), two from the Health Survey for England (HSE), two from the Child Heart and Health Study in England (CHASE), one from the National Child Measurement Programme (NCMP), and three from other study samples. Three of the studies from the MCS conducted longitudinal analyses whilst the remainder were cross sectional analyses. The included articles cover the ages 9 months to 15 years, although this review focuses on primary school aged children (4 to 11 years). Sample sizes ranged from 119 to 828,586.

The studies used a wide range of ethnic groupings, with different categories and types of aggregation to group the sample. Some studies explored these relationships in minority ethnic groups versus the general population, versus the White British group or with no comparison group. Minority ethnic groups investigated include Asian (grouped variously as Asian, South Asian, Indian, Pakistani, Bangladeshi, Urdu, Gujarati, Punjabi, other South Asian and other Asian); Black (grouped variously as Black, Black Afro-Caribbean, African, Black African and Black Caribbean and Other Black African Caribbean); other White (grouped as White Irish and other White); Chinese; and other ethnic groups. Three studies specifically compared groups whose parents were native versus foreign born (or children who were 'second generation' versus 'third generation').

The studies can be split into three types: 1) those that explored direct relationships between potential explanatory variables and adiposity in one ethnic group with no comparisons across groups (Henderson, 2010; Kelly *et al.*, 2012); 2) those that explored direct relationships between potential explanatory variables and adiposity with stratification by ethnic group (Blissett & Bennett, 2013; Brophy *et al.*, 2009; Higgins & Dale, 2012; Martinson *et al.*, 2012; Martinson *et al.*, 2015; Owen *et al.*, 2010; Rona & Chinn, 1987; Smith, 2010; Thomas *et al.*, 2012); and 3) those that explored the extent to which variables explained ethnic group differences in adiposity through adjusted regression models (Karlsen *et al.*, 2014; Martinson *et al.*, 2012; Townsend & Ridler, 2009; Zilanawala *et al.*, 2015). One study explored both direct relationships and the extent to which variables explained differences in adiposity (Martinson *et al.*, 2012).

Table 2.2 Characteristics of included studies

First author and year of publication	Study design	Age	Population	Sample size	Ethnic groups and sample bases	Explanatory variables and measures	Adiposity outcome variables and measures
Millennium Cohort Study							
Brophy *et al.* (2009)	Longitudinal	Time points: 1: 9 months 2: 5 years	Millennium Cohort Study (UK)	n=17,561	• White/European: time point 1 n=15,062 time point 2 n=11,967 • Asian: time point 1 n=1845 time point 2 n=1,331 • African: time point 1 n=654 time point 2 n=447	• Birthweight • Food behaviours • Physical activity • Sedentary behaviours • Child enjoyment of physical activity • Socioeconomic characteristics • Parental health behaviours (Mother pre-pregnancy weight; Smoking near child) • Parenting strategies	Weight status (BMI; obese); IOTF cut-offs
Kelly *et al.* (2012)	Cross sectional	5 years;	Millennium Cohort Study (UK)	n=2161	• Indian n=416 • Pakistani n=716 • Bangladeshi n=294 • Black Caribbean n=348 • Black African n=362	• Mothers' reported racism	Weight status (BMI; obese); IOTF cut-offs
Martinson *et al.* (2012)	Longitudinal	Time points: 1: 9 months 2: 3 years 3: 7 years	Millennium Cohort Study (England only)	n=6816	• Native-born White = 80.9% • Native-born Asian = 4.1% • Native-born Black = 2.2% • Foreign-born White = 4.2% • Foreign-born Asian = 6.8% • Foreign-born Black = 1.9%	• Maternal weight status • Mother's nativity (based on country of birth) • Mother's age at arrival in the host country • Socioeconomic status	Weight status (BMI; overweight); CDC cut-offs (85th centile)

First author and year of publication	Study design	Age	Population	Sample size	Ethnic groups and sample bases	Explanatory variables and measures	Adiposity outcome variables and measures
Martinson *et al.* (2015)	Longitudinal	Time points: 1: 9 months 2: 3 years 3: 5 years; 4: 7 years	Millennium Cohort Study (England data only)	n=6700	• Native-Born White n=5322 • Native-Born Asian n=289 • Native-Born Black n=151 • Foreign-Born White n=273 • Foreign-Born Asian n=504 • Foreign-Born Black n=161	• Mother's nativity (based on country of birth)	BMI
Smith (2010)	Cross sectional	5 years	Millennium Cohort Study (UK)	n=14,860	• White n=11,546 • Indian n=421 • Pakistani n=684 • Bangladeshi n=287 • Black Caribbean n=340 • Black African n=362 • Other White n=515 • Other n=461	• Father's, mother's and child's generation (born overseas = 1st generation; UK born = 2nd generation)	Weight status (BMI; overweight and obesity combined); IOTF cut-offs
Zilanawala *et al.* (2015)	Cross sectional	5 years	Millennium Cohort Study (UK)	n=18,280	• White n=15,003 • Indian n=518 • Pakistani n=926 • Bangladeshi n=376 • Black Caribbean n=487 • Black African n=459 • Other n=511	• Food behaviours • Socioeconomic characteristics • Mother's BMI • Mother's nativity • English spoken at home • Sleep routine	BMI; Weight status (BMI); IOTF cut-offs

First author and year of publication	Study design	Age	Population	Sample size	Ethnic groups and sample bases	Explanatory variables and measures	Adiposity outcome variables and measures
Health Survey for England							
Higgins and Dale (2012)	Cross sectional	2 - 15 years	Health Survey for England ethnic boost samples (1999;2004)	n=7407	• Black Caribbean: Boys n=348; Girls n=362 • Black African: Boys n=157; Girls n=144 • Indian: Boys n=391; Girls n=326 • Pakistani: Boys n= 522; Girls n=523 • Bangladeshi: Boys n=454; Girls n=399 • Chinese: Boys n=205; Girls n=196 • Irish: Boys n=385; Girls n=384 • White: Boys n=1184; Girls n=1067	• Mothers' socioeconomic status • Parental overweight / obesity	Weight status (BMI; overweight and obesity combined); IOTF cut-offs
Karlsen *et al.* (2014a)	Cross sectional	2 - 15 years	Health Survey for England (1998-2009)	n=48,802	• White English n=36,600 • White Irish n=917 • Other White n=1,051 • Black Caribbean n=1,748 • Black African n=1,118 • Indian = n=1,747 • Pakistani n=2,091 • Bangladeshi n=1,274 • Other South Asian n=899 • Chinese n=489 • Other n=868	• Equivalised household income	Weight status (BMI; overweight and obesity reported separately); IOTF cut-offs

First author and year of publication	Study design	Age	Population	Sample size	Ethnic groups and sample bases	Explanatory variables and measures	Adiposity outcome variables and measures
CHASE							
Owen *et al.* (2010)	Cross sectional	9 - 10 years	Recruited from schools with high proportion of minority ethnic groups in London, Birmingham and Leicester	n=2049	• White European n=499 • South Asian n=484 • Black African-Caribbean n=571 • Other n=495	• Physical activity by ActiGraph combined with questionnaire	Waist circumference; Ponderal index; Fat mass (leg-to-arm bioelectrical impedance and skinfold thickness)
Thomas *et al.* (2012)	Cross sectional	9 - 10 years	Recruited from schools with high proportion of minority ethnic groups in London, Birmingham and Leicester	n=4804 (complete cases only)	• White European n=1158 • Caribbean n=460 • African n=656 • Other Black African Caribbean n=85 • Indian n=408 • Pakistani n=477 • Bangladeshi n=323 • Other South Asian n=106 • Other Asian children n= 295 • Other ethnic origins n=836	• Socioeconomic status (parental occupation)	Waist circumference; Ponderal index; fat mass (leg-to-arm bioelectrical impedance and skinfold thickness)
NCMP							
Townsend and Ridler (2009)	Cross sectional	4-5 years and 10-11 years combined	NCMP data from 2007/8 (England); recruited from state schools	n=828,586	No sample bases provided • White British & Irish • Black African • Black Caribbean • Chinese • Indian • Pakistani • Bangladeshi	• Index of Multiple Deprivation (IMD)	Weight status (BMI; obese); UK90 reference chart (cut-offs not stated)

First author and year of publication	Study design	Age	Population	Sample size	Ethnic groups and sample bases	Explanatory variables and measures	Adiposity outcome variables and measures
Other							
Blissett and Bennett (2013)	Cross sectional	28–138 months	Purposive sample from schools in Birmingham	n=119 families	• British Black Afro-Caribbean: Boys n=10 Girls n=25 • White British: Boys n=16 Girls n=22	• Parental feeding practices (Comprehensive Feeding Practices Questionnaire and Dutch Eating Behaviour Questionnaire) • Child food behaviours (Child Eating Behaviour Questionnaire)	BMI SDS

First author and year of publication	Study design	Age	Population	Sample size	Ethnic groups and sample bases	Explanatory variables and measures	Adiposity outcome variables and measures
Henderson (2010)	Cross sectional	7-11 years	Recruited from schools with high South Asian population in Middlesbrough	n=133	• British Pakistani n=133: Second generation n=82 Third generation n=51	• Child's nativity (generation)	Height (cm); BMI (kg/m2); Waist:Height ratio; triceps SFT (mm); subscapular SFT (mm); and Triceps:subscapular SFT ratio. SDS for height; BMI; waist circumference; triceps SFT; and subscapular SFT. Weight status (BMI; overweight) and fat status (waist circumference, triceps SFT and subscapular SFT; overfat) categorised using UK90 BMI, 91st and 98th centiles cut-offs and IOTF BMI cut-offs.

First author and year of publication	Study design	Age	Population	Sample size	Ethnic groups and sample bases	Explanatory variables and measures	Adiposity outcome variables and measures
Rona and Chinn (1987)	Cross sectional	5-11 years	Main sample used National Study of Health and Growth data (England and Scotland; 1982) and ethnic boost sample targeted schools inner-city areas (1983)	n=6,675	• Caucasian n=2777 • Afro-Caribbean n=944 • Urdu n=462 • Gujarati n=536 • Punjabi n=1239 • Other Asians n=281 • Others n=436	• Number of children in family / No. siblings • School meals • Overcrowding • Mother's weight and height • Father's weight and height • Mother's education • Father's social class • Father's employment status • Mother's hours working outside home • Child's birthweight	Weight-for-height SDS; triceps skinfold thickness SDS

Table 2.3 provides a summary of the independent variables explored. Thirty four independent variables were explored across the included studies, using 50 different measures. These have been grouped into five broad categories/themes based on socioecological models of health behaviour (Harrison *et al.*, 2011b; Sallis *et al.*, 2008) and with guidance from the proposed framework of factors influencing race/ethnic disparities in child adiposity by Zilanawala *et al.* (2015).

Table 2.3 Summary of independent variables explored across included studies

Biological factors	Child factors	Family factors	Community factors
- Birthweight - Parental height	- Food behaviours (fruit consumption, regular meals, breakfast skipping) - Physical activity - Sedentary behaviours - Psychological factors (food approach, food avoidance, enjoyment of physical activity) - Sleep - Migration factors (foreign-born parent, mother's age at migration, composite measure)	- Parental health behaviours (weight status; smoking) - Parenting strategies (introduction of solid food, food restriction, food monitoring, pressure to eat, playing outdoors, playing indoors) - Family size - Single parenthood - Overcrowding - Income - Education - Employment - Class / status - Deprivation / poverty - Composite measure of sociodemographic factors	- Experiences of racism

A variety of outcome measures were used to indicate adiposity, as outlined in Table 2.4. Some studies utilised multiple metrics of adiposity. Adiposity was measured as both continuous and categorical variables. All studies used weight-to-height indices, some explored central distribution of adiposity (n=3) and some used indirect measures of fat mass (n=4). For weight status as a categorical variable, three studies explored obesity only, one studied overweight and obesity as separate categories and four explored overweight and obesity combined. Three different reference populations were used, with two studies using the UK-based chart (UK90) (Cole *et al.*, 1995), one using the US-based chart (CDC) (Kuczmarski *et al.*, 2000) and seven using the international (IOTF) reference (Cole *et al.*, 2000). For the studies using the UK90 reference population, some studies used clinical monitoring (higher) cut-offs (91st and 98th percentiles) and others used population monitoring (lower) cut-offs (85th and 95th percentiles) for overweight and obesity, respectively.

Table 2.4 Outcome measures used in included studies

Weight status	General obesity	Central obesity	Fat mass
IOTF reference (n=7) UK90 reference (n=2) CDC reference (n=1)	BMI (n=9) BMI z-score/SDS (n=2) Ponderal index (n=2) Waist-for-height SDS (n=1)	Waist circumference (WC) (n=3) Waist:Height ratio (n=1)	Bioelectrical impedance (n=2) Skinfold thickness (SFT) (n=4)

2.5.2 Study types and quality assessment

A summary of the quality rating of each paper is provided in Table 2.5. The quality of included studies varied, with one rated as poor (Rona & Chinn, 1987), three as good (Brophy *et al.*, 2009; Martinson *et al.*, 2012; Martinson *et al.*, 2015), and the remainder rated as fair. This was mostly due to their cross-sectional nature, and the potential for some bias in all of the included studies, due to the use of indirect measures of the exposure and outcome, variation in the sampling methods across ethnic groups or variation in the response or follow-up rates by ethnic group. Measures of ethnic group classification were well reported using established categories, but varied widely and justifications for categorisation were rarely reported. Most studies went to some effort to boost the sample bases for minority ethnic groups, yet some studies still potentially lacked the power to determine relationships therefore such studies may suffer from type II error in their findings (Blissett & Bennett, 2013; Henderson, 2010; Smith, 2010). All studies adjusted for some potential confounders and some conducted sensitivity analyses (Martinson *et al.*, 2012; Owen *et al.*, 2010; Thomas *et al.*, 2012), although there remains a risk of residual confounding: only two sets of analyses took into account clustering of participants at higher levels (Owen *et al.*, 2010; Thomas *et al.*, 2012). None of the included studies explicitly stated if the outcome measure was blinded.

Table 2.5 Quality assessment of included studies - overall judgement and key strengths and limitations

First author and year of publication	Quality assessment rating	Study type	Summary of limitations	Summary of strengths	Ethnicity
Millennium Cohort Study					
Brophy *et al.*, 2009	Good	Longitudinal	• Exposure measures mostly self-report • % lost to follow-up was high at >20% • Follow-up differed significantly across ethnic groups (White = 20.5%; Asian = 28%; African = 32%) •	• Large sample size • Sampling allowed for overrepresentation of ethnic minority groups • Statistical adjustment for potential confounders • Reporting quality good	• 11 census categories collapsed into three categories • Parental designation
Kelly *et al.*, 2012	Fair	Cross-sectional from cohort data	• Indirect measure of exposure • Differences in response rates across ethnic groups (ranging from 66.2% for Black Caribbean to 75.8% for Indian)	• Large sample size • Sampling allowed for overrepresentation of ethnic minority groups • Statistical adjustment for potential confounders • Reporting quality good	• Census categories collapsed into five categories • Parental designation
Martinson *et al.*, 2012	Good	Longitudinal	• Cannot determine participation or follow-up rate	• Large sample size • Sampling allowed for overrepresentation of ethnic minority groups • Statistical adjustment for potential confounders • Sensitivity analysis conducted using different cut-offs fro independent variables and with additional variables	• Census categories collapsed into three categories • Parental designation
Martinson *et al.*, 2015	Good	Longitudinal	• Cannot determine participation or follow-up rate	• Large sample size • Sampling allowed for overrepresentation of ethnic minority groups • Statistical adjustment for potential confounders • Sensitivity analysis conducted	• Census categories collapsed into three categories • Parental designation

First author and year of publication	Quality assessment rating	Study type	Summary of limitations	Summary of strengths	Ethnicity
Smith, 2010	Fair	Cross-sectional using cohort data	• Small sample bases in stratified analyses (risk of type II error) • Cannot determine if follow-up rate differed by ethnic group • Cannot determine if outcome measure was blinded	• Sampling allowed for overrepresentation of ethnic minority groups • Statistical adjustment for potential confounders	• 14 categories collapsed into eight categories • Parental designation
Zilanawala *et al.*, 2015	Fair	Cross-sectional using cohort data	• Some measures of exposure limited (e.g. nutrition) • Missing data varied by ethnic group and socioeconomic groups	• Sampling allowed for overrepresentation of ethnic minority groups • Statistical adjustment for potential confounders • Sensitivity analysis for complete cases analysis and imputation methods for missing data	• Census categories collapsed into seven categories • Parental designation
Health Survey for England					
Higgins & Dale, 2012	Fair	Cross-sectional	• Exposure variables mostly self-report • Response rate varied across ethnic groups (ranging from 62% for Black Caribbean to 80% for Indian) • Ethnic boost sample recruited / sampled in different way	• Power calculation reported • Sampling allowed for overrepresentation of ethnic minority groups • Statistical adjustment for potential confounders	• Census categories collapsed into seven categories vs general population • Parental designation
Karlsen *et al.*, 2013	Fair	Cross-sectional	• Exposure variables mostly self-report • Response rate varied across ethnic groups • Variations in the sampling methodologies adopted for ethnic boost sample • Variation in sample power across different years of measurement	• Sampling allowed for overrepresentation of ethnic minority groups • Statistical adjustment for potential confounders • Standard errors (SE) adjusted for clustering	• Census categories collapsed into eleven categories • Parental designation

First author and year of publication	Quality assessment rating	Study type	Summary of limitations	Summary of strengths	Ethnicity
CHASE					
Owen *et al.*, 2010	Fair	Cross-sectional	• Participation rates varied across ethnic groups (69% overall; ranged from 66% for African-Caribbean to 73% for South Asian)	• Sampling allowed for overrepresentation of ethnic minority groups • Objective measures of physical activity used • Adiposity measured using additional measures of fat mass • The demographic, ethnic and anthropometric characteristics of study participants who wore or did not wear an ACTi graph were similar • Statistical adjustment for potential confounders and clustering at sampling levels • Sensitivity analyses of those with fewer days ACTi graph data	• 14 categories collapsed into four categories • Self-defined ethnicity of both parents or (if not available) parentally defined ethnicity of the child
Thomas *et al.*, 2012	Fair	Cross-sectional	• Participation rates varied across ethnic groups (68% overall; ranging from 65% in African Caribbean to 71% in Other groups) • Sample power was low in stratified analyses due to small sample bases	• Sampling allowed for overrepresentation of ethnic minority groups • Statistical adjustment for potential confounders and clustering at sampling levels • Sensitivity analyses conducted (excluding the economically inactive groups) • Participation rates were similar across most ethnic groups (although rates were lower in Black African-Caribbean children) • Little evidence of selection bias	• 14 categories collapsed into ten categories • Self-defined ethnicity of both parents or (if not available) parentally defined ethnicity of the child

First author and year of publication	Quality assessment rating	Study type	Summary of limitations	Summary of strengths	Ethnicity
NCMP					
Townsend & Ridler, 2009	Fair	Cross-sectional	• Cannot determine participation rate across ethnic groups	• Large sample size • Statistical adjustment for potential confounders	• Census categories collapsed into seven categories • Linkage to education records (parent designated)
Other					
Blissett & Bennett, 2013	Fair	Cross-sectional	• Sampling methods may have introduced selection bias • Low participation rates (47.5%) and not clear if differed across ethnic groups • Small sample bases (risk of type II error) • Indirect measures of exposure (parental strategies) • No adjustment for multiple testing for large number of correlation tests	• Statistical adjustment for potential confounders • Use of validated questionnaires of exposure (parenting and eating behaviours)	• Two categories (and an additional White German sample that have not been included in this review) • Parental designation
Henderson, 2010	Fair	Cross-sectional	• Small sample bases (risk of type II error) • Low participation rate (33% for British Pakistani)	• Statistical adjustment for potential confounders • Use of several measures of adiposity e.g. skinfold thickness	• One ethnic group allocation based on census category • Parental designation
Rona & Chinn, 1987	Poor	Cross-sectional	• Variations in the sampling methodologies adopted for ethnic boost sample • Cannot determine participation rate or sampling power	• Sampling allowed for overrepresentation of ethnic minority groups • Use of additional measure of adiposity (skinfold thickness) • Statistical adjustment for potential confounders	• Seven categories • Designation by fieldworkers' subjective assessment of ethnicity and the language spoken at home

2.5.3 Patterns in prevalence across ethnic groups

Table 2.6 summarises the prevalence of overweight and/or obesity observed in the included studies, where reported. Seven studies did not report prevalence, reporting only mean BMI or odds of obesity. A high prevalence of overweight and/or obesity was consistently found in Black groups, especially the Black African group (ranging from 11.1% - 18.7% obese), in comparison to either White British children (5.1% - 5.5% obese) or the general population. There was inconsistency in weight status in the broad South Asian group, although disaggregated analysis tended towards a high prevalence of overweight and/or obesity in Bangladeshi children in particular (10.7% - 13% obese), and a low prevalence of overweight and/or obesity in Indian children (4.3% - 5% obese), whilst findings in other South Asian groups were largely inconsistent. Only one of the included studies reported prevalence by gender, comparing British Pakistani to White British children, and found that British Pakistani boys had a higher prevalence of excess weight (39% versus 29.9% using UK90 cut-offs ≥91st centile) whilst British Pakistani girls had a lower prevalence (24.4% vs 36.2%) (Henderson, 2010).

Table 2.6 Prevalence of ov/ob across ethnic groups for included studies (with 95% confidence intervals where reported)

First author and year of publication	Age	Cut-offs used	Ethnic groups (sample size)	Overweight	Obese	Overweight & obese
Millennium Cohort Study						
Brophy *et al.* (2009)	5 years	IOTF	White/European (n = 15062) Asian (n = 1845) Indian Pakistani Bangladeshi Other African (n = 654)		5.4% (5.0%-5.8%) 7.1% (5.8%-8.6%) 4.3% (2.6%-7%) 6.9% (5.2-9%) 11.7% (8.3%-16.2%) 5.4 (2.3%-12.1%) 11.7% (8.9%-15%)	
Kelly *et al.* (2012)	5 years	IOTF	Indian (n=416) Pakistani n = (716) Bangladeshi (n=294) Black Caribbean (n=348) Black African (n=362)		5% 6% 13% 12% 11%	
Martinson *et al.* (2012)	5 years	CDC 85th centile	Total sample (n=6816) Native born White (80.9%) Native born Asian (4.1%) Native born Black (2.2%) Foreign-born White (4.2%) Foreign-born Asian (6.8%) Foreign-born Black (1.9%)			33.4% 33.5% 27.6% 36% 38.1% 24.1% 45.3%
	7 years	CDC 85th centile	Total sample (n=6816) Native born White (80.9%) Native born Asian (4.1%) Native born Black (2.2%) Foreign-born White (4.2%) Foreign-born Asian (6.8%) Foreign-born Black (1.9%)			21.3% 20.7% 24% 29.6% 22.6% 19.2% 44%
Martinson *et al.* (2015)	3 years	CDC 85th centile	Total sample (n=6700) Native born White (n=5322) Native born Asian (n=289)			33.2% 33.5% 27.6%

First author and year of publication	Age	Cut-offs used	Ethnic groups (sample size)	Overweight	Obese	Overweight & obese
			Native born Black (n=151) Foreign-born White (n=273) Foreign-born Asian (n=504) Foreign-born Black (n=161)			36% 38.1% 24.1% 45.3%
Smith *et al.* (2012)	5 years	IOTF	White (n=11,546) Indian (n=421) Pakistani (n=684) Bangladeshi (n=287) Black Caribbean (n=340) Black African (n=362) Other White (n=515) Other (n=461)	15.6% 11.4% 11.6% 9.8% 15.4% 21.3% 13.3% 12.2%	5.1% 4.6% 6.4% 11.4% 11.1% 18.7% 14.6% 15.8%	
Zilanawala *et al.* (2015)	5 years	IOTF	White (n=15,003) Indian (n=518) Pakistani (n=926) Bangladeshi (n=376) Black Caribbean (n=487) Black African (n=459) Other (n=511)		5.5% 4.7% 6.5% 10.7% 11.4% 11.1% 6.2%	
Health Survey for England						
Higgins and Dale (2012)	2 - 15 years	IOTF	Not reported			
Karlsen *et al.* (2014)	2 - 15 years	IOTF	Not reported			
CHASE						
Owen *et al.* (2010)		Not measured				
Thomas *et al.* (2012)	9 - 10 years	Not measured				
NCMP						
Townsend and Ridler (2009)	4-11 years	UK90; cut-offs unknown	Not reported			
Other						
Blissett and Bennett (2013)	28–138 months	Not measured				

First author and year of publication	Age	Cut-offs used	Ethnic groups (sample size)	Overweight	Obese	Overweight & obese
Henderson (2010)	7-11 years	IOTF (>91st)	British Pakistani boys (n=59) White British boys (n=87) British Pakistani girls (n=78) White British girls (n=124)			30.5% 25.3% 25.6% 27.4%
		UK90 (>91st)	British Pakistani boys (n=59) White British boys (n=87) British Pakistani girls (n=78) White British girls (n=94)			39% 29.9% 24.4% 36.2%
Rona and Chinn (1987)	5-11 years	Not measured				

2.5.4 Description of factors influencing childhood obesity

Table 2.7 provides summaries of the study findings for each of the variables explored, organised using the SEM as a framework, and discussed in greater detail in the text below. Additional tables with greater detail, and sub-divided by ethnic group, are provided in Appendix 2-Appendix 5.

Table 2.7 Summaries of systematic review findings for each variable

Factor	Reference	Summary of findings
Biological factors		
Birthweight	Brophy *et al.* (2009)	+ve relationship with odds of obesity at age 5; no interactions by ethnic group
	Rona and Chinn (1987)	Significant associations with weight-for-height and triceps SFT for Caucasian and Punjabi children; weight-for-height for Gujarati children and African-Caribbean children; no association for Urdu, other Asian or other groups
Parental height	Rona and Chinn (1987)	Significant relationship between mother's height & child weight-for-height and triceps SFT for Caucasian; with weight-for-height for African-Caribbean and Punjabi children; no association for Gujarati, Urdu, other Asian and other groups. Significant relationship between father's height & child weight-for-height and triceps SFT for Gujarati; and with weight-for-height only for Caucasian, Punjabi and other Asian children; no association for African-Caribbean, Urdu or other ethnic groups.
Child factors		
Health behaviours		
Fruit consumption	Brophy *et al.* (2009)	No association after adjustment for income; no interactions across ethnic groups
	Zilanawala *et al.* (2015)	Minimal influence on BMI and odds of overweight/obesity
Regular mealtimes	Brophy *et al.* (2009)	No association after adjustment for income; no interactions across ethnic groups
Breakfast skipping	Brophy *et al.* (2009)	No association after adjustment for income; no interactions across ethnic groups
Physical activity	Brophy *et al.* (2009)	No association after adjustment for income; no interactions across ethnic groups
	Owen *et al.* (2010)	Inverse graded associations for physical activity counts with several adiposity markers; similar associations across White European, South Asian, Black African-Caribbean and other ethnic groups (no significant interactions)
Sedentary behaviour	Brophy *et al.* (2009)	Increased odds of obesity at age 5 for those watching >3 hours of TV per day; increased odds of obesity at age 5 for those playing > 3 hours of computers per day; no interactions across ethnic groups but remained significant in adjusted models for TV use only
Sleep	Zilanawala *et al.* (2015)	Inclusion of routine weekday bedtime attenuated odds of overweight in all groups; did not explain ethnic differences in BMI or odds of overweight or obesity versus White group

Factor	Reference	Summary of findings
Psychological factors		
Child food approach	Blissett and Bennett (2013)	+ve association between food approach score & BMI in Black African-Caribbean children only
Child food avoidance	Blissett and Bennett (2013)	No association; consistent across all ethnic groups
Enjoyment of physical activity	Brophy *et al.* (2009)	No association or interactions across ethnic groups in adjusted models (not measured in African group due to low sample base in categories)
Migration factors		
Foreign-born parent	Smith (2010)	No generational effect overall, but lower odds of overweight and obesity in children with second generation (native born) mothers versus first generation (foreign-born) mothers for Black Caribbean children only
	Martinson *et al.* (2012)	All Black groups had higher odds of overweight at age 7 vs White children with native born mothers; Black children with foreign-born mothers had higher odds of overweight versus Black children with native-born mothers; White children with foreign-born mothers did not differ from those with native-born mothers;
	Martinson *et al.* (2015)	Black groups had significantly higher growth trajectories age 3 to 7 vs White children with native born mothers; steeper BMI growth trajectories in Black children with foreign-born vs native-born parents; Asian children of foreign and native-born mothers had a significantly lower BMI than native-born White mothers at age 3 but native-born Asian children had significantly steeper growth trajectories vs native-born White
	Henderson (2010)	Mostly no significant associations with adiposity; except boys of second generation children had significantly higher odds of overweight vs third generation for BMI and SFT
Mother's age at arrival	Martinson *et al.* (2012)	No association; stratified analysis not possible for Black group due to low sample base
Composite measure of migration	Zilanawala *et al.* (2015)	Child's generation and primary language spoken at home combined did not explain the variation in odds of overweight and obesity or BMI seen across ethnic groups
Family factors		
Parental health behaviours		
Pre-pregnancy weight	Brophy *et al.* (2009)	Maternal pre-pregnancy weight of >60 kg doubled a child's odds of obesity at age five; no interactions across ethnic groups

Factor	Reference	Summary of findings
Mother's weight status	Rona and Chinn (1987)	Significantly associated with weight-for-height and triceps SFT in Caucasian; with weight-for-height in African-Caribbean, Punjabi and other Asian children; no association for Urdu, Gujarati or other ethnic groups
	Martinson *et al.* (2012)	Maternal obesity was significantly positively associated with overweight at age three and seven; did not mediate ethnic group disparities
	Higgins and Dale (2012)	Girls with an obese mother more likely to be overweight or obese; similar across all ethnic groups; boys with an obese mother were more likely to be overweight or obese except for Bangladeshi and Irish boys (no association)
	Zilanawala *et al.* (2015)	Mother's BMI mediated the relationship between sociodemographic factors and BMI in Black African children and other ethnic groups; in Indian group for overweight (no longer significantly lower). Higher odds of obesity became significant for Bangladeshi children after introduction of mother's BMI.
Father's weight status	Rona and Chinn (1987)	Significantly associated with weight-for-height and triceps SFT in Caucasian, Gujarati, Punjabi children; with weight-for-height in other Asian and other ethnic groups; no association for Urdu or African-Caribbean children
	Higgins and Dale (2012)	Boys with overweight or obese father were more likely to be overweight or obese; similar across all ethnic groups; girls with overweight or obese father were more likely to be overweight or obese except for White and Bangladeshi girls
Parental smoking	Brophy *et al.* (2009)	Parental smoking near the child also substantially increased child's odds of obesity at age five; no interactions across ethnic groups
Socioeconomic characteristics		
Parental education	Martinson *et al.* (2012)	-ve association with adiposity; significant interaction between education & Black ethnicity (native-born mother) only suggesting protective effect of low education
	Brophy *et al.* (2009)	-ve association with adiposity; consistent across all ethnic groups
	Higgins and Dale (2012)	-ve association with overweight for girls overall; inconsistent across ethnic groups. No association for boys; consistent across all ethnic groups
	Rona and Chinn (1987)	No association; consistent across all ethnic groups
Employment		

Factor	Reference	Summary of findings
Mother's hours working	Rona and Chinn (1987)	No association across most groups; significant association with weight-for-height in Caucasian children only
Father employment	Rona and Chinn (1987)	No association across most groups; significant association with weight-for-height in Caucasian children only
Income	Martinson *et al.* (2012)	No association overall; low income was protective for children of native-born Asian mothers and foreign-born Black mothers
	Brophy *et al.* (2009)	-ve relationship with adiposity; non-significant trend for African children in high income families to have a higher prevalence of obesity (sample base small)
	Karlsen *et al.* (2014a)	Accounted for the ethnic variation in overweight observed in boys only (test for ethnic group differences was no longer significant)
Class / status	Thomas *et al.* (2012)	-ve relationship between NS-SEC[1] and adiposity in White European children; no association in South Asian groups; potential +ve association for Black African-Caribbean children (relationship most clear using ponderal index)
	Rona and Chinn (1987)	Higher triceps SFT in those whose fathers were from semi-skilled manual class versus skilled manual class for African-Caribbean children only
	Higgins and Dale (2012)	Overall inverse association in boys only; stratified analysis showed inconsistent relationship across ethnic group in girls
Deprivation / poverty	Townsend and Ridler (2009)	+ve association with odds of obesity; explained some of the variation in obesity across ethnic groups (except for Chinese children)
	Rona and Chinn (1987)	Children with free-school meals had lower adiposity in the total sample, and by ethnic group, this was only the case for Caucasian children and other Asian children
Family size	Rona and Chinn (1987)	Weight-for-height and triceps SFT higher in smaller families for Caucasian and Punjabi children; and for Urdu children (triceps SFT only)
Overcrowding	Rona and Chinn (1987)	Significant association between overcrowding and triceps SFT for children from Caucasian, other Asian and other ethnic backgrounds only
Composite measure	Zilanawala *et al.* (2015)	Mother's employment, single parenthood, and SEP together explained some of the ethnic variation in adiposity i.e. accounted for high odds for obesity in Bangladeshi children (also attenuated high BMI in Black Caribbean and Black African children and amplified low BMI

Factor	Reference	Summary of findings
		in Indian and Pakistani children and those from other ethnic group but change was non-significant)
Parenting strategies		
Early introduction of solid food	Brophy *et al.* (2009)	Significant +ve relationship; no interaction across ethnic groups after adjustment
Playing with child outdoors	Brophy *et al.* (2009)	No association; consistent across ethnic groups
Playing with child indoors	Brophy *et al.* (2009)	Playing with children indoors everyday increased odds of obesity at age five; consistent across White European, African and Asian groups
Restrictive food practices	Blissett and Bennett (2013)	Significant +ve correlation with BMI for Black African Caribbean children only
Parental food monitoring	Blissett and Bennett (2013)	No association; no variation in relationship across ethnic groups
Parental pressure to eat	Blissett and Bennett (2013)	No association; no variation in relationship across ethnic groups
Community factors		
Experiences of racism	Kelly *et al.* (2012)	No association; no variation in relationship across ethnic groups

[1] National Statistics-Socioeconomic Class

2.5.4.1 Biological and anthropometric factors

Few biological and anthropometric factors were explored in the included studies, and of the two variables studied (birthweight and parental height) (Brophy *et al.*, 2009; Rona & Chinn, 1987), the findings in relation to ethnic group differentials were contradictory but describe a potential differential association across ethnic groups.

Birthweight was associated with weight status in two studies: one study showed a positive association between birthweight (>3.5kg) and odds of obesity at age 5 (unadjusted odds ratio = 1.4, 95% CI: 1.27-1.70) with no interactions by ethnic group (Brophy *et al.*, 2009); whilst the second showed significant associations mainly within Caucasian and Punjabi children ($p<0.001$), explaining a relatively large proportion of the variation in these groups (although only <2%), and to some extent for Gujarati ($p<0.001$) and African-Caribbean ($p<0.05$) children (weight-for-height only), but not Urdu, other Asian or other groups (Rona & Chinn, 1987) (this study used a working definition of ethnicity that incorporated language spoken at home).

In the study by Rona and Chinn (1987), a significant relationship between mother's height and child adiposity was found mainly for Caucasian children ($p<0.001$), across both weight-for-height and triceps SFT, and for Afro-Caribbean and Punjabi children (weight-for-height only); but not Gujarati, Urdu, other Asian and other groups. Mother's height explained the largest amount of variation of all social and biological factors for Afro-Caribbean children (1.4-1.6%). Father's height and child adiposity showed significant associations in Gujarati children (across both weight-for-height and SFT), and Caucasian, Punjabi and other Asian children (weight-for-height only); but not Afro-Caribbean, Urdu or other ethnic groups (Rona & Chinn, 1987).

2.5.4.2 Child factors

2.5.4.2.1 Health behaviours

Child food behaviours (fruit consumption, regular mealtimes and breakfast skipping) showed no association with weight status after adjustment for income, and this was consistent across ethnic groups (Brophy *et al.*, 2009; Zilanawala *et al.*, 2015). Physical activity and sedentary behaviours were explored by Brophy *et al.* (2009), who found increased odds of obesity at age 5 for those exercising <1 day per week (minutes of activity not stated) (unadjusted OR = 1.25, 95% CI: 1.08-1.45), watching more than 3 hours of TV per day (adjusted OR = 1.3, 95% CI: 1.2-1.5) and playing more than 3 hours of computers per day (unadjusted OR = 1.42, 95% CI: 1.0-2.07), with no interactions across ethnic groups (White European, Asian or African), although the findings relating to physical activity and computer use were non-significant after adjustment for socioeconomic factors. Overall physical activity levels measured objectively through an ActiGraph showed strong inverse graded associations with several adiposity markers (ponderal index, WC, SFT, fat mass index) in adjusted multilevel analyses conducted by Owen *et al.* (2010), with no significant interactions across White European, South Asian, Black African-Caribbean and other ethnic groups. There was a significant ethnicity interaction for the relationship between activity and triacylglycerol (triglycerides) levels and high density lipoproteins (HDL)-cholesterol, indicating a clear inverse relationship for White European children for triacylglycerol and a positive relationship with HDL-cholesterol for South Asian and Black African-Caribbean groups. However, these measures are outside the scope of the current review.

Routine bedtimes were less common in children from Black Caribbean and Black African backgrounds, and later bedtimes were observed in all minority ethnic groups, with Bangladeshi and Pakistani children having the highest proportions of children going to bed after 9pm. Having a routine weekday bedtime did not explain ethnic differences in BMI or odds of overweight or obesity versus the White group (Zilanawala *et al.*, 2015). However, once sleep was introduced into the regression model, the lower odds of overweight seen in Pakistani children became significant (OR = 0.71, 95% CI: 0.53–0.96; $p<0.05$) (although this significant difference is not retained in the final fully adjusted model).

2.5.4.2.2 Psychological factors

Of the three psychological variables explored, child's food avoidance consistently showed no association with adiposity measures across ethnic groups (Blissett & Bennett, 2013). Blissett and Bennett (2013) studied child's approach to food (a combination score of food responsiveness, emotional overeating, enjoyment of food, and desire to drink) and found Black African and Caribbean (BAC) parents reported significantly greater food-approach behaviours in their children than did White British (WB) parents (score in BAC = 13; WB = 10; MANCOVA = $p<0.001$), and the results of a MANCOVA revealed a positive association between food approach score and BMI in Black African-Caribbean children (coefficient = 0.42; $p<0.05$), but not White British children (coefficient = -0.17; $p>0.05$). Enjoyment of physical activity was associated with decreased odds of obesity in unadjusted models (unadjusted OR = 0.7; 95% CI: 0.5 – 0.95) and this lower odds of obesity was observed only in White/European children (it was not associated with obesity in Asian children and there were too few numbers to measure in African children). However, the ethnicity interaction was no longer significant in adjusted models.

2.5.4.2.3 Migration factors

Factors related to migration were explored in five papers (Henderson, 2010; Martinson *et al.*, 2012; Martinson *et al.*, 2015; Smith *et al.*, 2009; Zilanawala *et al.*, 2015), and showed a complex relationship with obesity across ethnic groups. In the MCS, Martinson *et al.* (2012) and Martinson *et al.* (2015) found that children of Black ethnicity had higher odds of overweight versus White children with native-born mothers at age seven, as well as significantly steeper trajectories of BMI growth from age three to seven. This was true of Black children with both foreign and native-born parents. However, those with foreign-born mothers exhibited a stronger and more consistent relationship with odds of overweight, and had steeper BMI growth trajectories than those with native-born parents in adjusted models (coefficient for odds of overweight: foreign-born Black = 0.99; p<0.01; native-born Black = 0.42; p<0.1; growth: foreign-born Black = 0.29; SE: 0.04; p<0.01; native-born Black = 0.15; SE: 0.04; p<0.01). For children of native-born Black mothers, odds of overweight was only significantly higher than children of native-born White mothers following the introduction of an interaction term with mother's low education (coefficient = 0.89; p<0.05). Similarly, disaggregated analysis of the MCS at age seven by Smith (2010) found lower odds of overweight and obesity in children with second generation (native-born) mothers versus first generation (foreign-born) mothers for Black Caribbean children only (adjusted OR = 0.23, 95% CIs: 0.07 - 0.74; p<0.05) in models adjusted for health-related behaviours and SES. This was also the case comparing Black Caribbean children to the White reference population: children with first generation mothers had a significantly higher odds of overweight and obesity (OR = 2.69; 95% CIs: 1.29-5.64 with adjustment for child age and sex and maternal age) whilst those with second generation mothers did not differ significantly to White children.

Asian children of foreign and native-born mothers had a significantly lower BMI than native-born White mothers at age three (Martinson *et al.*, 2015). Growth trajectories from three to seven were also steeper for Asian children of foreign and native-born mothers (growth = 0.06; SE: 0.03; p<0.05 and 0.1; SE: 0.03; p<0.01 respectively) versus native-born White, although BMI remained low at age seven. For White children, those born to foreign mothers did not differ significantly, either in BMI at age three or age seven, nor in BMI trajectory from three to seven years, from those with native-born mothers. Mother's age at arrival in the host country did not significantly impact upon risk of obesity across any ethnic groups.

In a study of 133 British Pakistani children in Middlesbrough, Henderson (2010) found no significant difference across several adiposity measures between second generation children (foreign-born parent) versus third generation children (native-born parent). Although there appeared to be a significantly higher proportion of overweight second generation British Pakistani boys (foreign-born parent) versus third generation (native-born parent) boys based on two measures of adiposity (IOTF cut-offs for BMI and UK90 cut-offs for subscapular SFT), analyses were not adjusted for potential confounding factors and the pattern was not consistent across other measures e.g. UK90 cut-offs for BMI, waist circumference or triceps SFT; nor for British Pakistani girls.

Zilanawala *et al.* (2015) studied the combined effect of child's generation and primary language spoken at home upon models stratified by ethnic group and adjusted for age, gender and sociodemographic characteristics, and found that these two factors did not explain the variation in odds of overweight and obesity seen across ethnic groups, although they did explain a relatively large proportion of the higher odds of obesity seen in Black Caribbean and Black African children (11% and 30% respectively).

2.5.4.3 Family factors

2.5.4.3.1 Parental health behaviours

Longitudinal analysis of the MCS found that a maternal pre-pregnancy weight of >60 kg almost doubled a child's odds of obesity at age five (OR = 1.9; 95% CI: 1.6-2.3 in adjusted models), whilst parental smoking near the child also substantially increased the odds (OR = 1.3, 95% CI: 1.02-1.6 in adjusted models) overall, with no interactions with White European, African or Asian ethnicity (Brophy *et al.*, 2009). In analyses stratified by income group, however, higher odds of obesity were found only for parents who smoke in high-income groups.

Parental weight status was studied in several of the included papers, with an overall positive relationship between parental weight status and child weight status, but with potential variation in the relationship by ethnic group. Rona and Chinn (1987) found that mother's weight was significantly associated with weight-for-height and triceps SFT in Caucasian children, explaining the largest amount of variation of all covariates (~3%), and with weight-for-height only in Afro-Caribbean, Punjabi and other Asian children, but not Urdu, Gujarati or other ethnic groups. Father's weight was significantly associated with weight-for-height and triceps SFT in Caucasian, Gujarati and Punjabi children, and with weight-for-height for those from other Asian and other ethnic groups, but not Urdu or Afro-Caribbean. In the HSE (Higgins & Dale, 2012), there were differences in the influence of maternal and paternal weight status by sex. For example, girls with an obese mother were more likely to be overweight or obese compared with those whose mother is neither overweight nor obese across all ethnic groups, but for boys this was not the case for all ethnic groups, with Bangladeshi and Irish boys showing no significant relationship. Likewise, boys with an overweight or obese father were more likely to be overweight or obese themselves across all ethnic groups, but for girls this was true for all groups except White and Bangladeshi girls.

In their analysis of the MCS, Zilanawala *et al.* (2015) found that Black mothers tended to have a higher BMI than other groups, whilst mothers from Indian and other ethnic groups had a lower BMI. When included in regression models, mother's BMI mediated the relationship between sociodemographic factors and BMI in Black African children (who no longer had a significantly higher BMI when adjusting for maternal BMI) and other ethnic groups (no longer had a significantly lower BMI), as well as odds of overweight in Indian children (no longer had significantly lower odds). Adding maternal BMI to the model also increased the high odds of obesity for Bangladeshi children to significant levels (OR = 1.7; 95% CI: 1.04-2.78 in adjusted model). This influence of maternal BMI upon child BMI in Bangladeshi children contrasts with the previous findings by Higgins and Dale (2012). Martinson *et al.* (2012) found that although maternal obesity was significantly positively associated with overweight at age seven in the MCS (coefficient = 0.85; p<0.01), it did not significantly mediate subgroup disparities when included in regression models.

2.5.4.3.2 Socioeconomic characteristics

Socioeconomic characteristics were the most commonly investigated variable across the included studies, with seven studies investigating some measure of socioeconomic position. However, all of these measures showed inconsistent or indeterminate relationships across ethnic groups to some extent, as described below.

Of the socioeconomic characteristics studied, several measures showed potential differential relationships across ethnic groups. Parental education, studied in four papers, was found to be negatively associated with adiposity in two analyses of the MCS (Brophy *et al.*, 2009; Martinson *et al.*, 2012) but largely unrelated to adiposity in the HSE and National Study of Health and Growth (Higgins & Dale, 2012; Rona & Chinn, 1987). Both Brophy *et al.* (2009) and Rona and Chinn (1987) found consistent relationships across all ethnic groups (although Brophy *et al.* (2009) found that the lower obesity levels found at higher educational levels were less obvious in the African group). Martinson *et al.* (2012) observed an interaction between education and ethnicity indicating a trend towards a protective effect of low education for non-White minority ethnic groups, although the interaction is significant for children of native-born Black mothers only (coefficient = -1.02; p<0.01 in fully adjusted models). Higgins and Dale (2012) found no statistically significant relationship for boys in any of the ethnic groups, but educational qualifications were inconsistently predictive of overweight and obesity across ethnic groups for girls. Analyses by ethnic group were not presented, but the overall association was inverse (high levels of education associated with low overweight and obesity).

The findings on income were similarly complex. One study found little relationship between income and adiposity overall (Martinson *et al.*, 2012) whilst another found a significant inverse relationship (Brophy *et al.*, 2009). Both found potential differential relationships across ethnic groups. Martinson *et al.* (2012) found that low income was protective for non-White ethnic groups, although after adjusting for maternal obesity this was only significant for children of native-born Asian mothers (coefficient = -0.87; p<0.05) and foreign-born Black mothers (coefficient = -1.13; p<0.1). Brophy *et al.* (2009) found no significant interactions across ethnic groups but there was an apparent trend (not statistically significant) for African children in high-income families to have a higher prevalence of obesity versus those from middle and low-income families. Contrastingly, Karlsen *et al.* (2014a) found that equivalised household income had minimal impact on the ethnic variations in overweight and obesity observed in the HSE overall, although the test statistic for ethnic variations in overweight was no longer significant in boys once equivalised household income was introduced to the model (p=0.1).

Three studies investigated measures of social class. Rona and Chinn (1987) found little relationship between father's social class and adiposity, with the exception of Afro-Caribbean children, with higher adiposity using triceps SFT in those whose fathers were from semi-skilled manual class versus skilled manual class (p<0.05). Higgins and Dale (2012) found an overall inverse relationship between social class and overweight and obesity for boys only, although in analyses stratified by ethnicity, no significant relationships for boys were evident. Although overall there was no relationship between mother's social class and adiposity for girls, in stratified analyses, it was inconsistently predictive in overweight and obesity across ethnic groups. The overall trend was for higher overweight and obesity in lower social class groups. Contrastingly, the CHASE study found that White European children from lower National Statistics-Socioeconomic Class (NS-SEC) groups had higher levels of adiposity across all measures of adiposity, whilst there was little evidence of an association in South Asian groups, and some evidence of a positive relationship between social class and adiposity for Black African-Caribbean children, particularly when using ponderal index (kg/m^3) (Thomas *et al.*, 2012).

Deprivation (measured as IMD) was associated with a small but statistically significant increase in the odds of obesity (1.01, 95% CI: 1.01, 1.01; $p<0.01$) in the NCMP (Townsend & Ridler, 2009) and explained some of the variation in obesity across ethnic groups. All ethnic groups continued to show higher odds of obesity compared to the White British & Irish reference group with the exception of Indian children, who no longer differed significantly from the reference group; and Chinese children who continued to show lower odds of obesity, after the introduction of IMD. In addition, free-school meal (FSM) status was associated with adiposity (children with free-school meals had lower adiposity) for Caucasian children and other Asian children in the National Study of Health and Growth (Rona & Chinn, 1987), in contrast to the expected relationship. Additional indicators of SEP were explored by Rona and Chinn (1987). There was little association between overcrowding and adiposity overall, although there was a significant association between overcrowding and triceps SFT for children from Caucasian, other Asian and other ethnic backgrounds. Number of siblings was consistently associated with adiposity in Caucasian and Punjabi children in adjusted models (higher in smaller families), and in Urdu children for triceps SFT only (explained the highest amount of variation for this group at around 2%). Father's employment status and mother's working hours showed little relationship to adiposity except in the Caucasian group (Rona & Chinn, 1987).

A composite measure of socioeconomic characteristics (mother's employment, single parenthood, and SEP) together explained some of the ethnic variation in adiposity in the MCS, in particular accounting for the high odds for obesity seen in Bangladeshi children, so that Bangladeshi children no longer differed from the reference group (Zilanawala *et al.*, 2015) (the majority of parents in this group were in the lowest groups for income and education and had the highest proportion of non-working mothers at 84.5% and the lowest proportion of single mothers at 5.8%). In addition, sociodemographic factors appeared to attenuate the high BMI seen in Black Caribbean and Black African children and amplify the low BMI seen in Indian and Pakistani children and those from other ethnic groups, although BMI still differed significantly to the White reference group, and sociodemographic profiles varied widely across these groups.

2.5.4.3.3 Parenting strategies

Six parenting strategies were studied across two studies (Blissett & Bennett, 2013; Brophy *et al.*, 2009). For the most part, these did not significantly impact upon adiposity (playing with child outdoors; parental food monitoring; and parental pressure to eat). Early introduction of solid food was associated with increased odds of obesity (OR = 1.2; 95% CI: 1.02-1.5 in adjusted models), and although this association was only significant in White European children in crude models, in adjusted models there was no difference across ethnic groups (Brophy *et al.*, 2009). Playing with child indoors every day increased odds of obesity at age five (OR = 1.06, 95% CI: 1.03-1.08 in adjusted model) and this was consistent across White European, African and Asian groups (Brophy *et al.*, 2009).

Although parental monitoring and parental pressure upon the child to eat were not significantly associated with BMI in children, use of parental restrictive food practices (i.e. restriction for weight control) was significantly positively correlated with BMI for Black African Caribbean children only (correlation = 0.52; $p<0.05$ versus 0.13; $p>0.05$ for White British) (Blissett & Bennett, 2013).

2.5.4.4 Community and social factors

Kelly *et al.* (2012) assessed experiences of racism in a sample of minority ethnic group mothers (Indian, Pakistani, Bangladeshi, Black African and Black Caribbean) taken from the MCS, and its cross-sectional association with obesity at age five. Although odds ratios were mostly >1.0, confidence intervals were large and indicated no significant relationships, particularly after adjustment for mother's age at time of birth, gender, languages spoken at home and ethnicity.

2.6 Discussion

A comprehensive systematic review of the literature has revealed a growing body of literature exploring potential determinants of ethnic variation in childhood adiposity across ethnic groups in the UK. The existing literature recognises complex pathways that lead to childhood adiposity, driven by interactions between biological, behavioural and contextual factors (Commission on Ending Childhood Obesity, 2016). Possible explanations for the variation in childhood adiposity across ethnic groups include variation in the occurrence of these explanatory factors, but also variation in how they interact to form the pathways that lead towards obesity (Gatineau & Mathrani, 2011). The findings from this review focus on 1) whether ethnic group differences in adiposity were explained by such factors; and 2) potential explanatory variables for which the relationship varied across ethnic groups.

2.6.1 Summary of findings

Table 2.8 summarises the review's findings for each variable explored, both regarding the overall relationship and the relationships specific to ethnic groups. The strength of evidence column indicates the number of studies that explored this variable, and the number of studies that supported an association, alongside indications of the quality of studies reporting an association.

Table 2.8 Relationships between potential explanatory variables and adiposity in the included studies

Factor	Summary finding	Strength of evidence[1]
Biological factors		
Birthweight	Positive relationship overall	2/2 studies (1 good, 1 poor)
	Potential ethnic group differences (+ve in Caucasian, some SA and Black groups)	1/2 studies but rated poor quality
Mother's height	Potential ethnic group differences in relationship (+ve in Caucasian, Afro-Caribbean and Punjabi)	1/1 study but rated poor quality
Father's height	Potential ethnic group differences in relationship (+ve in Caucasian, Punjabi, Gujarati & other Asian)	1/1 study but rated poor quality
Child factors		
Health behaviours		
Fruit consumption	No association	0/2 studies
Regular mealtimes	No association	0/1 studies
Breakfast skipping	No association	0/1 studies
Physical activity	Inverse relationship overall	1/2 studies (rated fair)
	Lack of evidence for ethnic group differences	0/2 studies
Sedentary behaviour	Positive relationship overall	1/1 study (rated good)
	Lack of evidence for ethnic group differences	0/1 study
Sleep	Routine bedtime attenuated adiposity in all groups	1/1 study (rated fair)
	Lack of evidence for a role in ethnic group differences	0/1 study
Psychological factors		
Child food approach	Positive association, BAC only	1/1 study (rated fair)
Child food avoidance	No association	0/1 study
Enjoyment of physical activity	No association	0/1 study
Migration factors		
	No overall association	0/1 study

Factor	Summary finding	Strength of evidence[1]
Foreign-born parent	Positive relationship between foreign-born mother and child adiposity in Black groups	3/3 studies (all MCS: 2 good, 1 fair)
	Potential positive relationship between foreign-born mother and adiposity in Pakistani boys	1/4 studies (rated fair)
	Stronger association with child adiposity in Asian children with UK-born mother relative to foreign-born	2/4 studies (both MCS, rated good)
	Explained a large proportion of ethnic variation in adiposity for Black African and Black Caribbean children	1/1 study (rated fair)
Mother's age at arrival	No association	0/1 study
Composite measure of migration	Lack of evidence for a role in ethnic group differences	0/1 study
Family factors		
Parental health behaviours		
Pre-pregnancy weight	Positive relationship overall	1/1 study (rated good)
	Lack of evidence for ethnic group differences	0/1 study
Mother's weight status	Positive relationship overall	2/2 studies (1 good, 1 fair)
	Potential positive association in Caucasian, Black and some Asian groups	1/2 studies but rated poor quality
	Potential gender-specific relationships (no relationship in Irish and Bangladeshi boys)	1/1 study (rated fair)
	Explained adiposity in Black African children	1/2 studies (rated fair)
Father's weight status	Potential ethnic group differences (positive association in Caucasian and some Asian groups)	1/2 studies but rated poor quality
	Potential gender-specific relationships (no relationship in White and Bangladeshi girls)	1/1 study (rated fair)
Parental smoking	Positive relationship overall	1/1 study (rated good)
	Lack of evidence for a role in ethnic group differences	0/1 study
Socioeconomic characteristics		
Parental education	Inverse relationship overall	3/4 studies (2 good, 1 fair)
	Potential positive relationship in children with native-born Black mothers	1/4 studies (rated good)
Mother’s employment	No association	0/1 study
Father’s employment	No association	0/1 study
Income	Inverse relationship overall	1/2 studies (rated good)
	Potential positive relationship in some Black and Asian groups	1/2 studies (rated good)

Factor	Summary finding	Strength of evidence[1]
	Accounted for ethnic group differences in adiposity	1/1 study (rated fair)
Class / status	Potential positive relationship in Black groups	1/3 studies (rated fair)
Deprivation / poverty	Positive association overall	1/1 study (rated fair)
	Explained some of the ethnic group differences in adiposity	1/1 study (rated fair)
Family size	Inverse relationship for Caucasian, Punjabi and Urdu	1/1 study but rated poor
Overcrowding	Positive relationship for Caucasian, other Asian and other ethnic groups	1/1 study but rated poor
Composite measure	Had a role in ethnic group differences in adiposity in most groups	1/1 study rated fair
Parenting strategies		
Early introduction of solid food	Positive association	1/1 study (rated good)
	Lack of evidence for a role in ethnic group differences	0/1 study
Playing with child outdoors	No association	0/1 study
Playing with child indoors	Positive association	1/1 study (rated good)
	Lack of evidence for a role in ethnic group differences	0/1 study
Restrictive food practices	Positive association in BAC only	1/1 study (rated fair)
Parental food monitoring	No association	0/1 study
Parental pressure to eat	No association	0/1 study
Community and social factors		
Experiences of racism	No association	0/1 study

[1] no. of studies finding relationship/no. of studies exploring relationship (denominator refers to studies that explored specific relationships, with specific ethnic groups or specific stratification e.g. boys and girls)

The extent of heterogeneity in the included studies limits the ability of this review to make conclusive statements of factors that are universally associated with adiposity and those which appear to vary across ethnic groups, and the extent to which such variables explain ethnic group differences in adiposity. Most variables were studied only once, and for those variables studied more frequently, different metrics were usually used which limited comparison; or findings generally did not fully support one another. For example, birthweight was explored in two studies with one finding differential relationships across ethnic groups, and the other finding a consistent positive relationship across all groups. Despite this heterogeneity, three key findings emerge from the synthesis.

Firstly, children of foreign-born Black mothers appeared to be at a greater disadvantage versus those of native-born mothers, and having a foreign-born parent explained some of the higher adiposity observed in Black groups; whilst for White children, mother's nativity had no effect and for Asian children, the relationship was less clear (with a possible protective effect of having a UK-born parent). This was supported to some extent by four papers out of five that explored this relationship (Martinson *et al.*, 2012; Martinson *et al.*, 2015; Smith, 2010; Zilanawala *et al.*, 2015), although each performed different analyses. It is important to note that all four papers supporting this relationship derived their findings from different iterations of the MCS, therefore the weight of evidence could not be described as strong.

Secondly, a possible protective effect of low income against adiposity in Black families exists (Brophy *et al.*, 2009; Martinson *et al.*, 2012). This finding was supported to some extent by two out of three studies, analysed in a variety of ways. However, one study found only non-significant trends, and two studies reporting this finding again used the same study population (MCS). These findings were not replicated consistently when using other measures of socioeconomic status, such as social class or deprivation (Thomas *et al.*, 2012; Townsend & Ridler, 2009) and remains tentative.

Thirdly, maternal weight status may be particularly important for children from Black groups (Rona & Chinn, 1987; Zilanawala *et al.*, 2015) and White groups (especially girls) (Higgins & Dale, 2012; Martinson *et al.*, 2012; Rona & Chinn, 1987), whilst father's weight may be more important for South Asian (especially Bangladeshi) and White boys (Higgins & Dale, 2012; Rona & Chinn, 1987). The findings related to mother's weight status (a positive relationship with child adiposity) were supported by two out of four studies, one of which was an analysis of the National Study for Health and Growth (Rona & Chinn, 1987), for which data were collected over 30 years ago and may no longer be representative of current relationships. The other study looked at the mediating effect of maternal weight status, and found this accounted for the high adiposity seen in Black children (Zilanawala *et al.*, 2015). Support for father's weight status (a positive relationship with child adiposity) came from two studies, one of which was the National Study for Health and Growth (Rona & Chinn, 1987). The findings relating to child gender came from only one study (Higgins & Dale, 2012).

There were also potential explanatory factors for child adiposity that varied across ethnic groups in a less consistent way, such as low parental education potentially being protective against adiposity for native-born Black children (Martinson *et al.*, 2012); and children's attitudes towards food (e.g. enjoyment of food and emotional overeating) and parental restrictive feeding patterns associated with obesity in Black African and Caribbean children, but not White British children (Blissett & Bennett, 2013). However, there was a lack of a large body of research to provide more definitive descriptions of these relationships. It is also worth noting that some of these differential associations may be due to differences in sampling power across ethnic groups.

2.6.2 Comparison to other literature

2.6.2.1 Prevalence of excess weight

As studies reporting prevalence only were excluded from this review, these findings do not provide a comprehensive overview of prevalence of excess weight across ethnic groups. In addition, a number of papers did not measure prevalence or did not report it. However, broad patterns in adiposity such as a high prevalence of excess weight in Black groups and Bangladeshi children, and a low prevalence in Indian children, were similar to those found in other studies (Dinsdale & Ridler, 2010; Dinsdale *et al.*, 2011; Dinsdale *et al.*, 2012; Karlsen *et al.*, 2014a; Ridler *et al.*, 2013; Sproston & Mindell, 2006; Zilanawala *et al.*, 2015) and in a systematic review of prevalence studies (El-Sayed *et al.*, 2011). El-Sayed *et al.* (2011) found the same gendered pattern for South Asian children as a broad ethnic group in their systematic review of prevalence studies i.e. a high prevalence for South Asian boys and low prevalence for South Asian girls. Data on other ethnic groups was either missing (e.g. Chinese) or showed inconsistent patterns (e.g. 'Other'); possibly due to the small sample bases for these groups or the heterogeneous nature of such groupings, a limitation also noted by El-Sayed *et al.* (2011).

2.6.2.2 Potential mechanisms of action for key findings

2.6.2.2.1 Migration

Children of foreign-born Black mothers were more likely to be overweight. Research carried out in African countries suggests large body size preferences and low social pressure to be slim (Toselli *et al.*, 2016). In the Millennium Cohort Study, foreign-born Black mothers were more likely to have arrived in the UK as adults compared to foreign-born Asian and White mothers (Martinson *et al.*, 2012), and so these culture-specific attitudes towards obesity may be well established and maintain a strong influence over the family following migration.

It is also important to understand if the relationship between migration and childhood adiposity is consistent across all Black groups in the UK. Smith *et al.* (2012) found the strongest migration-adiposity association in Black Caribbean children. Yet the Black Caribbean population in the UK has a very different migration history to the Black African population, are mostly British-born and have socioeconomic profiles more similar to the White British population (Law *et al.*, 2008). Much of the wider research on perceptions towards weight relate to the broad Black or African-Caribbean ethnic groupings, or do not include those from Caribbean backgrounds. One mixed methods study was identified exploring perceptions towards weight for Caribbean adults living in

South London with and without diabetes, and the researchers found that a larger body size was not culturally valued (Scott, 2001). However, this research only considered views of the weight status of adults, not children, and was a small sample (n=160). No other research could be found studying those living in the UK from Caribbean backgrounds alone.

2.6.2.2.2 Socioeconomic characteristics

There may also be a cultural explanation linked to migration driving the association between low income and low adiposity in Black families. Although the included studies did not all provide details on the migration patterns of the Black families in their samples, the 2011 census calculates that over half of Black individuals in the UK are non-UK born, the majority of which are Black African who migrated from African countries (Office for National Statistics, 2012), which tend to be countries with low-to-medium human development (United Nations Development Programme, 2015). A positive relationship between socioeconomic status and obesity has been consistently found in adults and children in countries with medium and low development (McLaren, 2007; Monteiro *et al.*, 2004). It may be that the drivers of this patterning continue to influence families further down the generations, following migration. One study found that the relationship was similar for those children of UK-born Asian mothers (but not foreign-born mothers) (Martinson *et al.*, 2012), which may also have an extended history of migration from countries ranked low-to-middle in human development.

It is of interest that some socioeconomic characteristics show a differential relationship across ethnic groups e.g. income; whilst others do not e.g. area deprivation; and so it may be the case that some socioeconomic characteristics exhibit universal influence or relevance regardless of ethnicity whilst others do not; or that the interplay between each element of socioeconomic status differs across ethnic groups.

2.6.2.2.3 Parental obesity

Parental obesity is a well-established risk factor for both childhood and adult obesity (Duran-Tauleria *et al.*, 1995; Lake *et al.*, 1997; Parsons *et al.*, 1999; Reilly *et al.*, 2005), and several studies have observed both a stronger influence of maternal than paternal weight status (Leary *et al.*, 2010; Whitaker *et al.*, 2010) and a stronger same-sex correlation i.e. between mother-daughter and father-son (Devakumar *et al.*, 2016; Perez-Pastor *et al.*, 2009; Power *et al.*, 1997). Gender-linked roles of mothers and fathers, contrasting parenting behaviours (or responses to obesity) of mothers and fathers upon boys and girls, or varying responses to parenting from boys and girls, and the interaction of all of these, may result in differences in the patterning of maternal-paternal-child obesity (Campbell *et al.*, 2006; Costanzo & Woody, 1985; Johannsen *et al.*, 2006; Nickelson *et al.*, 2012; Russell *et al.*, 1998). These interactions may be in part driven by the parent's weight status (Haycraft & Blissett, 2008). It is plausible that there are ethnic differences in these parenting roles, styles and interactions, for example the extent to which mothers are responsible for the family diet and eating behaviours, or gendered parental beliefs about weight. Potential ethnic variation in gender-specific responses have not been thoroughly explored in relation to child obesity nor parental weight status.

Another point for consideration is the differing family structures observed across ethnic groups: in the MCS, Black children were most likely to come from single parent households / have unmarried parents whilst Asian children were least likely, which may explain some of the ethnic group differences in relative influence of maternal and paternal obesity (Martinson *et al.*, 2012; Zilanawala *et al.*, 2015).

2.6.3 Strengths and limitations

2.6.3.1 Methodology of the synthesis

The use of multiple measures of some exposure variables e.g. income and SES; and the inconsistency in ethnic groupings, prohibited the use of a meta-analysis. Although narrative synthesis was used, which has been criticised in the past due to the potential for bias in the findings (Higgins & Green, 2011), the use of a structured synthesis, as outlined by Popay *et al.* (2006), supported the comprehensive interrogation of findings.

For example, there were contradictory findings for some relationships, both across and within the same study population. Such discrepancies were highlighted through the tabulation of relationships (e.g. positive, negative, universal and differential findings by ethnic groups etc.) alongside study characteristics, highlighting that contrasting findings may be due to the use of different variables or metrics e.g. use of self-report versus ActiGraph for physical activity (Brophy *et al.*, 2009; Owen *et al.*, 2010); different measures of adiposity (Henderson, 2010); or ethnic groupings, such as aggregated versus disaggregated groups when studying birthweight (Brophy *et al.*, 2009; Rona & Chinn, 1987).

To guide the synthesis, the number of articles that supported relationships provided some indication of the strength of associations. However, this must be interpreted cautiously: support for some of the key findings comes from multiple analyses of single studies e.g. MCS; HSE; CHASE (14 sets of analyses from seven data sets) and presenting counts alone would be misleading. Instead, the findings were reported alongside brief descriptions of the evidence base for each finding and its weaknesses, resulting in more cautious conclusions.

Use of a socioecological model was valuable in providing a framework to support identification of gaps in the existing literature. Just one of the included studies explicitly used a socioecological framework to identify potential determinants of ethnic disparities across childhood obesity (Zilanawala *et al.*, 2015). However, an assumption is made that such frameworks are universal in their coverage. It may be the case that such frameworks differ by ethnic group i.e. the explanatory factors that feature within a socioecological framework for Black groups may differ to those for South Asian groups.

2.6.3.2 Issues relating to the quality of included studies

The quality assessment judgements did not play a key role in the selection of studies and the synthesis. If findings had have been weighted by the quality assessment of the papers upon which they are based, one of the key findings would be considered weak, and there would be a reduction in support of the role of ethnic group differences in the influence of maternal and paternal obesity. This would be a result of the decline in the influence of the National Study for Health and Growth (Rona & Chinn, 1987) (rated poor), which found differential relationships across ethnic groups, and an increase in the weight of longitudinal analysis of the MCS (Martinson *et al.*, 2012) (rated good), which found no interactions across ethnic groups.

2.6.3.3 Issues relating to the validity of included studies

2.6.3.3.1 Relevance of measure of adiposity

Four studies used multiple measures of adiposity (Henderson, 2010; Owen *et al.*, 2010; Rona & Chinn, 1987; Thomas *et al.*, 2012), and provide some insight into their relative sensitivity in detecting ethnic variation. Three of these found contrasting relationships between the exposure and outcome depending on the measure of adiposity, or the BMI reference chart used (Henderson, 2010; Rona & Chinn, 1987; Thomas *et al.*, 2012). Rona and Chinn (1987) found that correlations between triceps SFT and weight-for-height were weak for the Afro-Caribbean group, and this translated into substantially lower adiposity versus Caucasian children using adjusted mean triceps SFT, but a similar level of adiposity to Caucasian children when using adjusted mean weight-for-height. This is supported by a number of more recent studies in which weight-for-height differs in its diagnostic accuracy across ethnic groups, reportedly underestimating adiposity in South Asian children and overestimating adiposity in Black children (Freedman *et al.*, 2008; Haroun *et al.*, 2010; National Obesity Observatory, 2009; Wang, 2002). Since most of the findings from the included studies are based on weight-for-height measures, there is a possibility that the high risk of adiposity observed in Black children in particular, and the resulting relationships, may be a result of measurement bias.

There is also the possibility that diagnostic accuracy differs across BMI reference charts and cut-offs, and that specificity and sensitivity may differ across ethnic groups (Reilly, 2002). However, ethnic-specific cut-offs for overweight and obesity are not yet recommended in children as they are in adults (Viner *et al.*, 2010).

2.6.3.3.2 Ethnic group classifications

Key limitations relating to ethnic group classifications in this review are 1) the lack of consistency in ethnic groupings across studies, hindering the ability to compare and contrast findings and make clear judgements of the weight of evidence behind relationships across different groups; and 2) the common use of aggregated groups in the included studies, which may disguise heterogeneity across subgroups within a larger grouping. In addition, few studies provided justifications for their ethnic groupings, resulting in under-theorised conceptions of the mechanisms behind ethnic variation in relationships (Nazroo, 1998). Some ethnic groupings were also overlooked in the included studies e.g. Chinese children, White children with migrant backgrounds or marginalised groups e.g. Roma.

2.6.3.4 Issues relating to the validity of review findings

The review included studies that investigated only direct relationships with obesity. It is probable that there are many other studies that have investigated the relationships of explanatory factors with behaviours on the obesity pathway e.g. diet, which may have proved informative. However, given the inconsistency in the literature on the strength of evidence behind some proposed obesogenic behaviours in childhood, e.g. dietary behaviours such as fruit consumption, it was felt the findings would be more robust by exploring only direct relationships.

There are several factors with proven links to adiposity across the general child population that have not been explored in the included studies, such as sugar sweetened beverage consumption (Malik *et al.*, 2013), additional measures of diet or eating behaviours (Moreno & Rodriguez, 2007), breastfeeding (Arenz *et al.*, 2004) and age of adiposity rebound (Monteiro & Victora, 2005; Taylor *et al.*, 2005). It may be that studies of such relationships have involved some stratification of analyses by ethnic group, but that these findings were not reported and therefore these papers were excluded from the review. This could increase the possibility of bias in the findings due to the underrepresentation of papers with null findings.

2.6.4 Implications

A number of reviews have looked at ethnic differences in adiposity and weight-related behaviours such as physical activity, inactivity and diet in a UK population (El-Sayed *et al.*, 2011; Eyre & Duncan, 2013; Gilbert & Khokhar, 2008; Labree *et al.*, 2011; Landman & Cruickshank, 2001; Leung & Stanner, 2011; Long *et al.*, 2009; Osei-Kwasi *et al.*, 2016), although few have focused on childhood. One review investigated the potential determinants of ethnic inequalities in childhood obesity, but found only two relevant studies (El-Sayed *et al.*, 2011). The current review found several studies that have explored some of these potential determinants in more recent years, going some way to address the gaps in the literature identified by El-Sayed *et al.* (2011).

A number of primary studies were found that investigated the determinants of childhood obesity across ethnic groups, and found both universal determinants and potential differential relationships across groups. There is a possibility that some of the factors driving childhood obesity differ in their influence across ethnic groups, which has implications for the design of preventative actions and treatment interventions. However, the evidence behind these relationships is often inconsistent or supported by only a small number of studies, which limits the ability to draw firm conclusions and make recommendations for practice. It is also unclear the extent to which universal and differential relationships explain ethnic group differences in adiposity.

2.6.5 Remaining gaps in the literature

This review has highlighted a lack of evidence investigating the role of ethnicity in relationships between potential explanatory factors at the community, social and country levels of influence and adiposity, and the extent to which such factors explain ethnic differences in child adiposity. Some community and social factors have been shown to have differential relationships across ethnic groups in the US e.g. neighbourhood poverty (Kimbro & Denney, 2013); and adults in the UK e.g. proximity to fast food outlets (Fraser et al., 2012); but no studies were found in this search that have examined these in children in the UK. However, there is a general lack of literature exploring how factors at the country / macro-level influence obesity in the general population.

Parenting strategies, child psychological variables and child birthweight may be important determinants of ethnic disparities in child health, but appear under-investigated. In addition, although this review included studies of the influence of migrant generation on childhood obesity, it did not include any investigations using more operationalised measures of acculturation, such as health behaviours or social mobility. The findings on the relationship between racism and adiposity in this review are consistent with those found in studies of children outside of the UK (Priest et al., 2013), but are in contrast with those in adults, in which racism showed a significant negative influence upon adiposity (Paradies et al., 2015). Further research on the relationship between racism and childhood adiposity may focus on potential differential effects across ethnic groups (Paradies et al., 2015), or use more comprehensive and more direct measures of racism, including the influence of racialised stereotypes at individual and institutional levels (Kelly et al., 2012).

This review found only a small number of studies that stratified by child gender as well as ethnic group, and detailed findings were not well reported. Yet the review found gender-specific responses to exposure variables that may differ across ethnic groups e.g. maternal obesity. It is also known that obesity becomes more well established in later childhood (Public Health England, 2016) yet none of the included studies conducted sub-group analyses to separate age groups. Research exploring ethnic variation in childhood obesity should aim to stratify by child gender and age group in order to identify such relationships.

In summary, there remains many gaps in the literature on the factors driving childhood obesity across ethnic groups, across all levels of influence, but priorities for research include the influence of acculturation; parenting strategies (in particular gendered beliefs and roles); the drivers of the relationship between income and adiposity; the relative importance of the various components of socioeconomic disadvantage e.g. environmental versus household; and the nature of physiological differences across ethnic groups, and its implications for how adiposity is measured. Some of these topics may be more deeply explored through qualitative research. From a methodological perspective, future research would benefit from additional longitudinal studies, greater consistency and use of disaggregated ethnic groupings, more robust measures or multiple measures of adiposity, and additional stratification by sex and age group.

2.7 Conclusions

Through the systematic identification of literature and synthesis of included studies, this review has highlighted a number of key relationships that may help to explain some of the variation in adiposity observed across ethnic groups. However, the review has mostly served to highlight the lack of robust existing evidence to understand the basis of ethnic group inequalities. This is in part due to the broad and multi-factorial nature of obesity, and the fact that most primary studies explored a different dimension of these determinants, therefore the overall findings of this review lack power and support. It is also partly due to methodological weaknesses in existing literature e.g. the cross-sectional nature of studies. In addition, some of the drivers of ethnic group differences may be better explored by qualitative research, which was not included in this review. Although the findings limit the identification of recommendations for practice, a number of gaps in the literature and directions for future research are proposed, including further investigation of the interaction between socioeconomic characteristics and ethnicity, stratification of analyses by sex, and use of disaggregated ethnic groupings.

2.8 Chapter summary

This chapter outlines the conduct and findings of a systematic review of the literature investigating factors associated with childhood overweight and obesity in minority ethnic groups in the UK, in order to aid understanding of how individual, cultural and contextual factors contribute to overweight and obesity prevalence across ethnic groups. Further investigation of the ethnic group differences in childhood adiposity, and potential explanations for such differences, is provided in Chapter 3, through the secondary analysis of a large cross-sectional database of child weight status for primary school children in Coventry. Chapters 4 and 5 use qualitative methods to explore the drivers of ethnic group differences, a recommendation from the current review.

Chapter 3 Multilevel analysis of individual and contextual factors contributing to ethnic disparities in adiposity in primary school children in Coventry

3.1 Chapter outline

This chapter aims to address the lack of existing evidence to understand the basis of ethnic group inequalities in childhood adiposity, as identified in the systematic review of the literature described in Chapter 2. The chapter is made up of three sections. The first is the analysis of local cross-sectional child measurement data for Coventry to ascertain the nature of any variation in BMI across ethnic groups for children aged 4-5 years and 10-11 years. This analysis also explores the potential influence of individual, school and neighbourhood factors upon BMI using a multilevel modelling approach. The second section repeats this approach using odds of overweight and obesity as the outcome of interest, in order to help contextualise the extent of any ethnic variation in BMI. The third section provides an exploration of some of the key considerations when measuring ethnic group variation in childhood BMI and overweight and obesity and how these influence interpretation of the findings, including anthropometry (height); body composition (body fat) and diagnostic criteria for classifying child weight status.

3.2 Background

Existing cross-sectional and longitudinal analyses highlight ethnic variation in childhood obesity in the UK, with Black ethnic groups exhibiting a consistently high prevalence of overweight and obesity, particularly Black African children, whilst Chinese children generally show a low prevalence of overweight and obesity (Health and Social Care Information Centre, 2014b; Karlsen *et al.*, 2014a; Sproston & Mindell, 2006; Zilanawala *et al.*, 2015). Patterns observed in other ethnic groups are less consistent across data sets, but suggest a possible increased risk in South Asian children also, especially in later childhood (Health and Social Care Information Centre, 2014b). The data also suggest variation across ethnic groups in the effect of sex, height, deprivation and time (year of measurement) upon BMI and prevalence of childhood obesity (Dinsdale *et al.*, 2014; El-Sayed *et al.*, 2011; Karlsen *et al.*, 2014a).

Although researchers have widely acknowledged that the determinants of childhood obesity act and interact within a socioecological model with multiple levels of influence (Butland *et al.*, 2007; Davison & Birch, 2001; Harrison *et al.*, 2011b; Sallis *et al.*, 2008), until recently, studies have tended to explore the effect of determinants across these levels upon weight status at the individual level only. Such an approach fails to account for aggregate variability in health outcomes and can result in group level correlations being inappropriately used to make inferences at the individual level (Duncan *et al.*, 1996).

More recently, studies exploring the determinants of childhood obesity in UK populations have begun to explore and account for aggregate variability at the school, neighbourhood and regional levels using multilevel analysis (Pallan *et al.*, 2014; Townsend *et al.*, 2012; Williams *et al.*, 2015). Although these studies explored and accounted for the role of ecological contexts within their analyses, with ethnicity incorporated as a variable for a variety of purposes, the studies did not explore potential differential effects of covariates across ethnic groups. This study therefore builds on the existing literature by aiming to explore variation in BMI across ethnic groups, and the influence of potential explanatory factors, within the context of their school and neighbourhood, using a multilevel approach.

An additional consideration when exploring ethnic variation in child adiposity is the influence of ethnic differences in anthropometry and body composition upon metrics of child adiposity. For example, BMI (weight in kg/height in m^2) may not fully adjust for the influence of height upon weight in children, so may systematically overestimate the degree of adiposity in tall children (Cole, 1986; Freedman *et al.*, 2003). Ethnic group differences in height may therefore account for some of the observed ethnic variation in child BMI and weight status. Some studies have found that weight-for-height measures underestimate adiposity in South Asian children and overestimate adiposity in Black children on the basis of body composition (Daniels *et al.*, 1997; Haroun *et al.*, 2010; National Obesity Observatory, 2009; Shaw *et al.*, 2007; Wang, 2002). Hudda *et al.* (2017a) have recently produced a set of adjusted BMI values for children from South Asian and Black African backgrounds, based on direct measures of body fat, derived from the pooled analyses of four recent UK studies. Adjustments for the differential influence of height and body composition upon BMI may therefore overcome ethnic-specific diagnostic issues in identifying adiposity in UK child populations.

As detailed in section 1.3.4.1, child weight status is based on comparisons to reference populations. Classification of children into weight status categories can be based on centile cut-offs derived from these reference populations, or can be related to a BMI value at a given age, intended to be indicative of adult disease risk. The ethnic composition of the reference population upon which comparisons are made is an important consideration when exploring ethnic variation on adiposity. For example, the UK90 reference population is based entirely on a White British sample (see section 1.3.4.1). In addition, the use of cut-offs based on centiles versus absolute BMI values may also result in a difference in the proportion of children classified as overweight or obese.

An additional aim of this study therefore was to assess the influence of making adjustments to the metrics used for assessing child adiposity in the current analyses upon the patterns of ethnic variation in child BMI and weight status observed.

3.3 Part 1: Ethnic disparities in BMI

3.3.1 Study aims

This element of the study aimed to answer the following questions:

1. Are there any differences in BMI across ethnic groups, and do these vary by sex or over time?
2. Is there a substantial effect of school or neighbourhood upon BMI as a whole and are these related to school or neighbourhood characteristics?
3. Does the effect of school and neighbourhood characteristics upon BMI vary across ethnic groups?
4. Does the combination of all these elements therefore account for the differences in BMI seen across ethnic groups?

3.3.2 Methods

3.3.2.1 Data set

3.3.2.1.1 National Child Measurement Programme (NCMP)

The NCMP is a national health surveillance programme in which the heights and weights of children in reception year (aged 4 – 5 years) and year 6 (aged 10-11 years) in participating state schools in England are taken to estimate childhood overweight and obesity prevalence. Parental consent is gained through an opt-out process. Measurements are taken and recorded by trained staff using a published protocol (Public Health England, 2015) and submitted electronically to a centralised system (Health and Social Care Information Centre, 2015a; Public Health England, 2015).

Annual data collected from the NCMP for Coventry over the period 2007/8 – 2014/15 was combined to allow for a large data set. Participation in Coventry is high, with 98% of eligible children taking part in 2014/15 (Health and Social Care Information Centre, 2015b), although this varied slightly across the data period.

Use of the NCMP data set was permitted through a data processing agreement with Coventry City Council. In addition to the NCMP data set, supplementary data were gathered to build covariates at the school and neighbourhood level, as detailed below.

3.3.2.1.2 Individual level variables

BMI z-score (zBMI) was used as the outcome variable. zBMI describes the standard deviation score of BMI-for-age-and-sex in relation to an external UK90 reference population (Cole et al., 1995; Cole et al., 1998; Must & Anderson, 2006). A zBMI of zero is equivalent to the mean for the UK90 reference population (i.e. indicating a BMI at the 50th centile), with a positive value indicating a zBMI in excess of the UK90 mean and a negative value indicating a zBMI below the UK90 mean. Overweight and obesity was defined using population monitoring cut-offs of ≥85th centile (zBMI of +1.04) for overweight and ≥95th centile (zBMI of +1.64) for obese.

Ethnicity data forms part of the NCMP data collection procedure and was compiled from the school information management system or child health record based on parent report. For the purpose of these analyses, ethnic groupings were aggregated to form 12 codes: White British, White other, Indian, Pakistani, Bangladeshi, any other Asian background, Black Caribbean, Black African, any other Black background, Chinese, mixed ethnicity and any other ethnic background. Groupings were based on the desire to have the largest number of distinct groups to account for heterogeneity, whilst allowing for adequate sample bases. A more detailed reference of ethnic groupings can be found in Appendix 6.

Additional individual level covariates included, and collected as part of the NCMP, were gender, age (in months) and year of measurement.

3.3.2.1.3 School and neighbourhood level variables

School level variables were selected to reflect aspects of school quality, the physical environment around the school, and pupil characteristics. Index of multiple deprivation (IMD) decile for school postcode was included as a school level categorical covariate. IMD is a composite measure of area deprivation, and is described in greater detail in Table 3.1 (McLennan *et al.*, 2011).

Table 3.1 Domains of each index of deprivation in the IMD and performance indicators by domain (McLennan *et al.*, 2011)

Index	Indicators
Income Deprivation Domain (the proportion of the population in an area experiencing deprivation related to low income)	The sum of individuals per LSOA for the following: • Adults and children in families receiving Income Support; Income-Based Jobseeker's Allowance; Pension Credit (Guarantee); and Child Tax Credit (who are not in receipt of Income Support, Income-Based Jobseeker's Allowance or Pension Credit) whose equivalised income (excluding housing benefits) is below 60 per cent of the median before housing costs • Asylum seekers in England in receipt of subsistence support, accommodation support, or both Additional indices: • Income Deprivation Affecting Children Index: proportion of children aged 0-15 living in income deprived households • Income Deprivation Affecting Older People Index: proportion of older people aged 60 and over living in income deprived households
Employment Deprivation Domain (involuntary exclusion of the working age population from the labour market)	The sum of individuals per LSOA for the following: Women aged 18-59 and men aged 18-64, averaged) who are: • Claimants of Jobseeker's Allowance, Incapacity Benefit, Severe Disablement Allowance or Employment Support Allowance • Participants in New Deal (for 18-24s; 25+ or Lone Parents) who are not in receipt of Jobseeker's Allowance
Health Deprivation and Disability Domain (premature death and the impairment of quality of life by poor health)	• Age and sex standardised measures of premature death (Years of Potential Life Lost); morbidity and disability (Comparative Illness and Disability Ratio); and acute morbidity (rate of emergency admissions to hospital) • Proportion of adults under 60 suffering from mood or anxiety disorders
Education, Skills and Training Deprivation Domain	Children/young people index: • Average points score of pupils taking English, Maths and Science for exams for Key Stage 2 and Key Stage 3 • Average capped points score of pupils taking Key Stage 4 (GCSE or equivalent) exams • Proportion of young people not staying on in school or non-advanced education above age 16 • Secondary school absence rate (authorised and unauthorised) • Proportion of those aged under 21 not entering Higher Education. Adult skills index: Proportion of adults aged 25-54 with no or low qualifications
Barriers to Housing and Services Domain (physical and financial accessibility of housing and key local services)	Wider barriers: Household overcrowding (proportion of households with insufficient space to meet the household's needs); Homelessness (acceptances for housing assistance under the homelessness provisions of the 1996 Housing Act); and Difficulty of access to owner-occupation (households aged under 35 whose income means they are unable to afford to enter owner occupation). Geographical barriers: Road distance to a GP surgery; supermarket or convenience store; primary school; and Post Office.
Crime Domain (risk of personal and material victimisation at a small area level)	Reported crime numbers per 1000 at risk population: Violent crimes, Burglary, Theft and Criminal damage
Living Environment Deprivation Domain (quality of individuals' immediate surroundings)	The indoors living environment: • Social and private housing in poor condition • Houses without central heating The outdoors living environment: • Air quality • Road traffic accidents

Pupil intake (number on school roll), proportion of children from Black and Minority Ethnic Groups (% BME), proportion of children with English as a second language (% ESL), and proportion of children achieving level 4 or above in Key Stage 2 tests (% KS2) for each school was obtained for each year of measurement. However, some of these variables were missing for some academic years, in which case data from the previous or following year was used, as described in Appendix 7. Ofsted grades were obtained from the Ofsted website. Since Ofsted inspections are not conducted annually, the Ofsted rating for each school for each year of data collection was taken as the rating from the most recent previous report, with four artificial categories of overall effectiveness created to account for differing inspection formats over the measurement period, and re-coding based on use of similar terms and judgement criteria (Appendix 8). The final school level variable was a count of takeaways within a 400m buffer (straight line radius) surrounding the child's school, using the Local Authority's FSA Food Hygiene Rating Scheme (Food Standards Agency, 2018) list to identify businesses and MapInfo Stratus to map postcodes and create the variable.

IMD decile for each child's postcode was included as a neighbourhood level categorical covariate.

A summary table of all variables and their descriptions is provided in Table 3.2.

Table 3.2 Independent variables at the child, school and neighbourhood level

Level	Variable	Format	Data source	Data period	Detail
Child	Ethnicity	Categorical	NCMP	Per year	12 categories
	Height z-score	Continuous	NCMP	Per year	Based on UK90 Reference charts
	Year of measurement	Continuous	NCMP	Per year	2006/7 – 2014/15
	Sex	Binary	NCMP	Per year	Male or Female
School	School IMD decile	Continuous	NCMP	Per year	Based on school postcode
	Pupil intake	Continuous	DfE School Census	2008/9 - 2014/15	The number of children across all classes on the school roll for that year.
	% Non-White British ethnicity	Continuous	DfE School Census	2008/9 - 2014/15	Based on whole school population. Ethnicity was categorised into White British, Non-White British and not stated.
	% English as second language	Continuous	DfE School Census	2008/9 - 2014/15	This is a measure of children whose first language is one other than English. It is not an indication of proficiency in the English language or nationality.
	% achieving Level 4+ in Key Stage 2 (KS2) in 3Rs	Continuous	DfE School Census	2008 - 2015	Those achieving Level 4+ for KS2 for the 3Rs.
	Ofsted grade	Categorical	Published full Ofsted reports from website (Ofsted, 2016)	Most recent preceding report to date of measurement	Schools are graded 1 – 4 for 'overall effectiveness'
	No. takeaways within 400m buffer of school postcode	Continuous	Food Standards Agency (FSA) website (Food Standards Agency, 2018)	2016	MapInfo was used to create a 400m buffer around each school, with the final variable being a count of the number of businesses classed as a 'takeaway/sandwich shop', as recorded by the Food Standards Agency, within the buffer.
Neighbourhood	Neighbourhood IMD decile	Continuous	NCMP	Per year	Based on child postcode

3.3.2.2 Data preparation

Data for children attending independent or special schools and those with conditions that reduce the ability to take accurate, reliable measurements were not included in the submitted data set. Participants were removed from the data set if they had missing data for ethnicity, IMD or Lower Super Output Area[8] (LSOA), in order to allow for complete case analysis. Children with invalid codes for ethnicity, or those with ethnicity 'not stated' were also removed. Analyses were restricted to those attending school and residing within the boundaries of Coventry. Supplementary school data were appended to the NCMP dataset in Stata v13. Additional data coding and cleaning was performed and is described in Appendix 9.

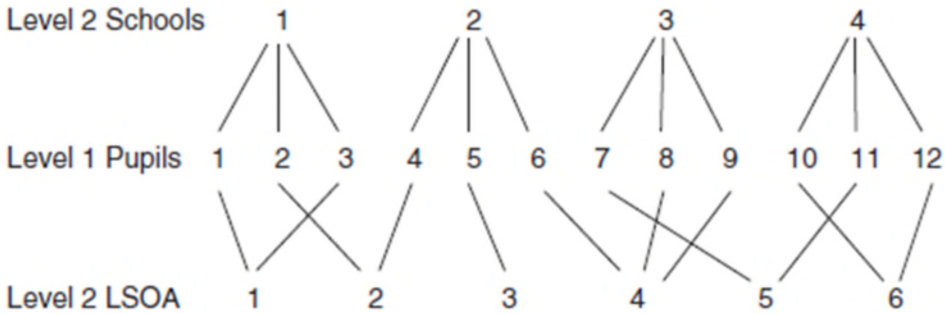
3.3.2.3 Analysis

Analyses were conducted separately for reception year and year 6 as previous analyses suggests differential associations across a range of variables and BMI by year group, including ethnicity (Health and Social Care Information Centre, 2014a). In addition, to understand if there were any sex-related patterns in ethnic differences in childhood BMI, stratified analysis was also undertaken for girls and boys in each year group.

Data were analysed firstly as a two-level cross-classified model, with the child as the level one unit and school and child LSOA (neighbourhood) as the level two units (as outlined in Figure 3.1). Markov Chain Monte Carlo (MCMC) methods were utilised since they provide greater flexibility for complex non-hierarchical structures compared to traditional maximum likelihood-based methods (Browne, 2016). A simple two-level structure with only school random effects fitted was also tested, and all structures were compared to single level linear regression models.

[8] Lower Super Output Area refers to a geographical area with a minimum of 1000 inhabitants (and a mean of 1500) (National Statistics, 2008)

Figure 3.1 Cross-classified data structure



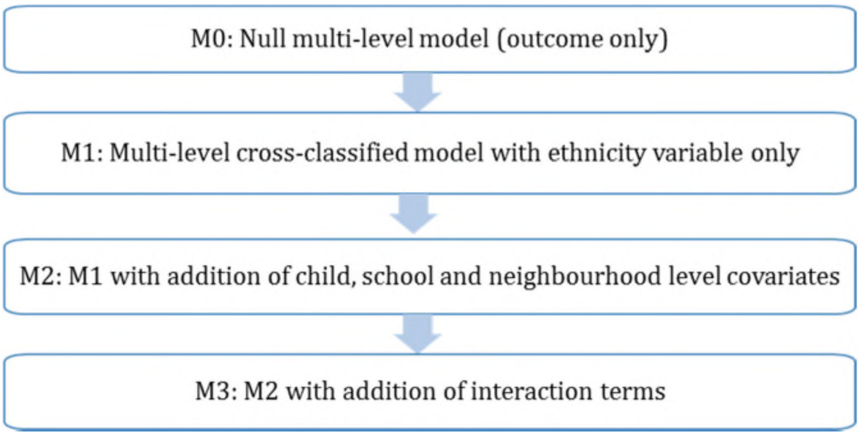
Source: Adapted from Townsend *et al.* (2012)

Analyses were conducted in Stata v14 using MLWiN v2.36 (Rasbash *et al.*, 2009) for multilevel analysis through the *runmlwin* code (Leckie & Charlton, 2013).

A number of models were created to explore the influence of covariates at each level, as outlined in Figure 3.2:

- a null multilevel model with random effects for school and neighbourhood (null model)
- a model with ethnic group added, to establish the unadjusted zBMI and amount of variance attributable to ethnic group (model 1);
- models with retained child, school and neighbourhood level covariates (model 2); and
- a model with retained interaction terms fitted (model 3).

Figure 3.2 Process of building the multilevel model for zBMI



3.3.2.3.1 Fitting the model

Retained covariates and interaction terms were those that improved the model fit based on a reduction in the Bayesian Deviance Information Criterion (DIC) of greater than five (MRC Biostatistics Unit, 2017).

The model fitting process was as follows:

1. Each explanatory variable was tested in the model alongside the outcome variable independently.
2. Each explanatory variable was ranked on the basis of the improvement in model fit versus the null model (based on the DIC value). Those that did not improve model fit (DIC <5) were removed at this stage.
3. The multivariate model (model 2) was then built using a stepwise, sequential approach, with the highest ranked variable added first, then the next highest ranked, and so on. With each additional variable, the model fit was compared to the previous model. If model fit was improved (DIC >5), the variable was retained and the next highest ranked variable was added. If model fit was not improved (DIC<5), the variable was dropped.
4. The final model was also tested with the ethnicity variable retained versus the ethnicity variable dropped to check this variable was still relevant in the final model (based on a DIC >5).

5. Once the final model was arrived at, interaction terms were fitted (model 3). For each model, interaction terms for the ethnicity variable and any retained covariate were fitted individually (interaction terms were not fitted for those variables that were dropped, nor for sex due to stratification for sex in subsequent models).
6. For each interaction term introduced, model fit was tested against the final model without interaction terms. The interaction term was retained if it improved model fit (DIC >5). As there were no models in which fit was improved with multiple interaction terms, it was not necessary to undertake sequential introduction of interaction terms.

3.3.2.3.2 Presentation of results

The proportion of variation explained by the addition of covariates at each level was calculated from the residual error variances for the null model versus the final model.

Regression coefficients and variance partition coefficients (VPC) (i.e. the proportion of the total variance accounted for) along with 95% Bayesian credible intervals[9] (CIs) (referring to the 2.5th and 97.5th quantiles of the posterior distribution) and p values (one-tailed p values based on the posterior distributions) are presented in the results, alongside the DIC. MCMC does not assume asymptotic normal sampling distributions, therefore some Cis cross zero yet have a p value indicative of significance at the 95% level (i.e. for a positive estimate, the p value is the proportion of that parameter's posterior distribution that is below zero. For a negative estimate, the p value is the proportion of that parameter's posterior distribution that is above zero). A description of the formula used for the multilevel modelling can be found in Appendix 10.

[9] Credible intervals are displayed in data reporting on the multilevel models, whilst confidence intervals are reported elsewhere i.e. in the sample description. Both use the abbreviation CIs, and the intended abbreviation is described as a footnote in each table

3.3.3 Results

3.3.3.1 Sample description

After removal of observations meeting the exclusion criteria (n=3266), the total sample consisted of 54,170 unique observations (28,407 in reception year and 25,763 in year 6) in 84 schools and 197 neighbourhoods. Table 3.3 shows the population characteristics and Table 3.4 the mean zBMI and percentage overweight or obese (ov/ob) for individual, school and neighbourhood-level variables. The population mean zBMI values of 0.34 for reception year and 0.52 for year 6 show that the mean BMI for the population is higher than that of the UK90 reference population (0), with these means equivalent to BMI values at the 63rd and 70th centiles respectively. One school did not have data recorded for attainment in KS2 as it was an infant school, and as such does not undertake KS2 tests; therefore initial analysis of reception year data was based on complete cases only (n = 27,803).

Table 3.3 Sample description for individual, school and neighbourhood level variables for reception year and year 6

	Reception	**Year 6**
INDIVIDUAL LEVEL VARIABLES		
Sex	n (%)	n (%)
Female	13,828 (49)	12,667 (49)
Male	14,579 (51)	13,096 (51)
Ethnicity		
White British	16,055 (57)	15,992 (62)
White other	1,655 (6)	1,190 (5)
Mixed ethnicity	1,827 (6)	1,422 (5)
Indian	2,335 (8)	2,283 (9)
Pakistani	1,540 (5)	1,381 (5)
Bangladeshi	460 (2)	470 (2)
Other Asian backgrounds	1,089 (4)	834 (3)
Black Caribbean	244 (1)	236 (1)
Black African	2,376 (8)	1,483 (6)
Other Black backgrounds	312 (1)	160 (1)
Chinese	130 (1)	71 (0.3)
Any other ethnic group	384 (1)	241 (1)
Year of measurement		
2007/08	2,869 (10)	3,120 (12)
2008/09	3,093 (11)	3,003 (12)
2009/10	3,354 (12)	3,256 (13)
2010/11	3,465 (12)	3,265 (13)
2011/12	3,635 (13)	3,234 (13)
2012/13	3,985 (14)	3,266 (13)
2013/14	3,848 (14)	3,192 (12)
2014/15	4,158 (15)	3,427 (13)
	Mean (95% CIs[1])	Mean (95% CIs)
Age (months)	59.7 (59.7, 59.8)	132 (132.0, 132.1)
SCHOOL LEVEL VARIABLES		
School IMD Quintile	n (%)	n (%)
1 (lowest deprivation)	2,183 (8)	2,167 (8)
2	4,125 (15)	3,836 (15)
3	7,249 (26)	6,813 (26)
4	5,596 (20)	5,000 (19)
5 (highest deprivation)	9,254 (33)	7,947 (31)
Ofsted		
Good or above	16,623 (59)	14,938 (58)
Satisfactory or below	11,784 (42)	10,825 (42)
	Median (IQR[2])	Median (IQR)
Number in school	396 (226)	398 (236)
% BME	38 (31)	36 (30)
% ESL	22 (27)	21 (27)
% KS2	75 (18)	75 (19)
Takeaways near school	2 (4)	2 (4)
NEIGHBOURHOOD LEVEL VARIABLES		
Neighbourhood IMD Quintile		
1 (lowest deprivation)	1,165 (4)	1,383 (5)
2	3,541 (13)	3,663 (14)
3	5,371 (19)	5,250 (20)
4	6,944 (24)	6,236 (24)
5 (highest deprivation)	11,386 (40)	9,231 (36)

[1] Confidence Interval [2] Inter Quartile Range

Table 3.4 Mean zBMI and percentage overweight/obese by individual, school and neighbourhood level variables for reception year and year 6

	Reception		Year 6	
INDIVIDUAL LEVEL VARIABLES				
Sex	Mean zBMI (SD[1])	% ov/ob[2] (95% CIs[3])	Mean zBMI (SD)	% ov/ob (95% CIs)
Female	0.33 (1.05)	22 (22,23)	0.45 (1.24)	33 (33,34)
Male	0.35 (1.13)	24 (24,25)	0.59 (1.23)	37 (36,37)
Ethnicity				
White British	0.41 (0.97)	24 (23,24)	0.51 (1.19)	33 (33,34)
White other	0.28 (1.07)	21 (19,23)	0.57 (1.24)	37 (34,40)
Mixed ethnicity	0.33 (1.11)	23 (21,25)	0.58 (1.26)	37 (34,39)
Indian	-0.09 (1.32)	17 (16,19)	0.37 (1.41)	35 (33,37)
Pakistani	0.05 (1.29)	20 (18,22)	0.48 (1.44)	39 (37,42)
Bangladeshi	0.24 (1.35)	27 (24,32)	0.73 (1.37)	46 (41,50)
Other Asian backgrounds	0.17 (1.15)	19 (17,22)	0.5 (1.26)	35 (32,39)
Black Caribbean	0.47 (1.14)	32 (26,38)	0.74 (1.2)	41 (35,47)
Black African	0.58 (1.18)	32 (30,34)	0.71 (1.21)	42 (40,45)
Other black backgrounds	0.49 (1.22)	32 (27,38)	0.88 (1.15)	44 (36,52)
Chinese	-0.03 (0.99)	15 (10,22)	0.16 (1.21)	23 (14,34)
Any other ethnic group	0.37 (1.25)	25 (21,30)	0.38 (1.23)	30 (24,36)
Year of measurement				
2007/08	0.38 (1.08)	25 (23,26)	0.47 (1.22)	34 (32,35)
2008/09	0.37 (1.05)	23 (22,25)	0.53 (1.2)	35 (33,36)
2009/10	0.38 (1.06)	23 (22,24)	0.54 (1.23)	35 (34,37)
2010/11	0.38 (1.08)	24 (23,26)	0.56 (1.21)	36 (34,37)
2011/12	0.37 (1.09)	24 (23,26)	0.52 (1.25)	36 (34,37)
2012/13	0.25 (1.07)	21 (19,22)	0.5 (1.26)	34 (33,36)
2013/14	0.29 (1.18)	25 (24,26)	0.53 (1.26)	35 (34,37)
2014/15	0.32 (1.08)	23 (22,24)	0.52 (1.27)	35 (34,37)

	Reception		Year 6	
4 quantiles of Age (months)				
1	0.37 (1.08)	24 (23,25)	0.54 (1.22)	35.3 (34,36)
2	0.34 (1.09)	23 (22,24)	0.53 (1.22)	34.7 (33,36)
3	0.33 (1.08)	23 (22,24)	0.52 (1.26)	35 (34,36)
4	0.31 (1.11)	23 (22,24)	0.49 (1.25)	35 (34,36)
SCHOOL LEVEL VARIABLES				
School IMD Quintile				
1 (lowest deprivation)	0.14 (1.04)	17 (15,19)	0.35 (1.21)	29 (27,31)
2	0.28 (1.00)	20 (19,21)	0.41 (1.17)	30 (28,31)
3	0.39 (1.05)	25 (24,26)	0.51 (1.22)	34 (33,35)
4	0.39 (1.09)	26 (24,27)	0.57 (1.24)	37 (35,38)
5 (highest deprivation)	0.34 (1.16)	24 (23,25)	0.6 (1.29)	39 (37,40)
Ofsted				
Good or above	0.31 (1.09)	23 (22, 23)	0.5 (1.23)	34 (34,35)
Satisfactory or below	0.37 (1.09)	25 (24, 25)	0.6 (1.25)	36 (35, 37)
4 quantiles of number in school				
1	0.39 (1.06)	25 (24,26)	0.51 (1.22)	34.3 (33.1,35.5)
2	0.38 (1.06)	24 (23,25)	0.56 (1.22)	35.8 (34.6,36.9)
3	0.31 (1.11)	23 (22,24)	0.51 (1.25)	34.7 (33.5,35.9)
4	0.27 (1.13)	22 (21,23)	0.5 (1.27)	35 (33.9,36.2)
4 quantiles of % BME				
1	0.34 (1)	22 (21,23)	0.48 (1.18)	33 (32,34)
2	0.37 (1.06)	24 (23,25)	0.51 (1.21)	34 (33,35)
3	0.36 (1.07)	24 (23,25)	0.53 (1.27)	36 (34,37)
4	0.28 (1.21)	23 (22,24)	0.56 (1.3)	38 (37,39)
4 quantiles of % ESL				
1	0.35 (1)	23 (22,24)	0.47 (1.19)	33 (31,34)
2	0.38 (1.05)	24 (23,25)	0.51 (1.21)	34 (33,35)
3	0.35 (1.09)	24 (23,25)	0.55 (1.26)	36 (33,37)

	Reception		Year 6	
4	0.28 (1.2)	23 (23,24)	0.55 (1.3)	37 (36,37)
4 quantiles of % KS2				
1	0.35 (1.11)	24 (23,25)	0.58 (1.27)	37 (36,39)
2	0.36 (1.09)	24 (23,25)	0.53 (1.25)	36 (33,37)
3	0.33 (1.1)	23 (22,24)	0.48 (1.22)	33 (32,34)
4	0.32 (1.06)	23 (22,23)	0.49 (1.2)	33 (32,35)
4 quantiles of takeaways near school				
1	0.34 (1.07)	23 (22,23)	0.5 (1.23)	34 (33,35)
2	0.35 (1.1)	24 (23,25)	0.57 (1.26)	37 (35,38)
3	0.37 (1.06)	24 (23,25)	0.53 (1.21)	35 (34,36)
4	0.29 (1.16)	23 (22,25)	0.51 (1.28)	35 (34,37)
NEIGHBOURHOOD LEVEL VARIABLES				
Neighbourhood IMD Quintile				
1 (lowest deprivation)	0.04 (1.04)	14.3 (12,17)	0.28 (1.19)	27 (25,29)
2	0.27 (1.01)	20 (19,22)	0.41 (1.18)	31 (29,32)
3	0.34 (1.04)	23 (22,24)	0.49 (1.21)	33 (32,34)
4	0.37 (1.07)	24 (23,25)	0.54 (1.24)	36 (35,37)
5 (highest deprivation)	0.37 (1.14)	25 (24,26)	0.6 (1.28)	38 (37,39)
Total	**0.34 (1.09)**	**23 (23,24)**	**0.52 (1.24)**	**35 (34,36)**

[1] Standard deviation [2]≥85th centile based on UK90 reference data [3] Confidence intervals

There were significant differences in sample characteristics by ethnic group. A summary of these differences is provided below, and the data are presented in detailed tables in Appendix 11 and Appendix 12.

3.3.3.1.1 Summary of sample differences across ethnic groups

The proportion of children measured per year was relatively constant for most ethnic groups, but there was an increase in the proportion of children from White other backgrounds and Black other backgrounds in particular in later years of the data period, especially in reception year.

Children from most minority ethnic groups tended to go to schools in more deprived areas, with the exception of Indian and Chinese children and those from mixed backgrounds (in addition to White British children). The Chinese group were the only group in which the majority of children attended schools in the least deprived quintiles. Chinese children also tended to go to schools with a high Ofsted rating and a high proportion of children achieving level 4 in Key Stage 2 tests. White British children similarly attended schools with a higher mean proportion of children performing to level 4 in Key Stage 2 tests, and schools with the lowest number of takeaway shops nearby.

Children from all minority ethnic groups, except Chinese children, attended schools where a high proportion of pupils spoke English as a second language. The schools attended by most Pakistani and Bangladeshi children tended to be located in the most deprived areas (≥67% in the most deprived quintile, compared to 32% in the whole sample), with a relatively high number of fast food restaurants nearby, rated highly by Ofsted, and having a very high proportion of children who spoke English as a second language (70%). Black African children attended schools with a high mean proportion of takeaway restaurants nearby.

Neighbourhood characteristics showed similar patterns for White British, Indian and Chinese children, with a relatively high proportion of these children living in areas of comparatively low deprivation (≤30% in the highest quintile, compared to 38% in the whole sample). Pakistani, Bangladeshi, Black African and Black Caribbean groups had the highest proportion of children living in deprived areas (≥69% in the most deprived quintile).

3.3.3.2 Refining the model

Based on the DIC, the cross-classified multilevel model had the best fit compared to the simple multilevel model and the single level model, therefore a cross-classified structure was pursued (see Appendix 13). After the addition of (fixed) explanatory covariates, the best-fitting mixed-effects regression model differed for reception year and year 6, and for boys versus girls, resulting in different covariates and interaction terms being retained in the final models. Table 3.5 shows the covariates and interaction terms retained, and more detail on DIC values is provided in Appendix 14.

Table 3.5 Model fitting process (BMI models)

	Reception			**Year 6**		
Covariate	**Whole sample (n = 27,803)**	**Girls (n = 13,524)**	**Boys (n = 14,279)**	**Whole sample (n = 25,763)**	**Girls (n = 12,667)**	**Boys (n = 13,096)**
Ethnicity	Retained	Retained	Retained	Retained	Retained	Retained
Sex	Retained	n/a	n/a	Retained	n/a	n/a
Year of measurement	Retained	Retained	Retained	Dropped	Dropped	Dropped
Age	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped
School IMD	Dropped	Dropped	Dropped	Dropped	Retained	Retained
Ofsted rating	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped
School intake	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped
% BME	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped
% ESL	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped
% KS2	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped
Count of takeaways	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped
Neighbourhood IMD	Retained	Retained	Retained	Retained	Retained	Retained
	n = 28,407	**n = 13,828**	**n = 14,579**	**n = 25,763**	**n = 12,667**	**n = 13,096**
Year interaction	Dropped	Dropped	Dropped	n/a	n/a	n/a
School IMD interaction	n/a	n/a	n/a	n/a	Dropped	Dropped
Neighbourhood IMD interaction	Dropped	Dropped	Retained	Dropped	Dropped	Dropped

3.3.3.3 Findings stratified by school year group and sex

3.3.3.3.1 Reception year

Table 3.6 shows the coefficients, decomposition of variance and model fit values for reception year children.

In reception year, most minority ethnic groups had a significantly lower zBMI than the White British group with the exception of Black groups and those from other ethnic groups, who mostly had a zBMI similar to the White British group (Model 1, Table 3.6).

Children from Black African backgrounds had a significantly higher zBMI compared to the White British reference group (a zBMI increase of 0.15 [0.10,0.20] $p<0.001$ compared to White British in model 1). Following the addition of child, school and neighbourhood factors (year of measurement and neighbourhood IMD), coefficients remained largely similar (Model 2, Table 3.6).

In this year group, the mean zBMI declined by a small but significant amount over time (a decline in zBMI of -0.02 [-0.02,-0.01] $p<0.001$ per year in model 2), whilst neighbourhood deprivation was positively associated with zBMI, after controlling for ethnicity (an increase in zBMI of 0.02 [0.01,0.03] $p<0.001$ per IMD decile in model 2). Age, sex and school characteristics did not contribute to the predictive power of models so were not retained in the final models. Cross-level interaction effects were tested, introducing terms for ethnicity X year of measurement and ethnicity X neighbourhood IMD, but these did not improve the model fit so were not retained in the model.

Table 3.6 Regression coefficients and variance partition coefficients for school and neighbourhood for models 0 to 2, reception year

	Null model	**Model 1 [1]**	**Model 2 [2]**
FIXED EFFECTS			
White British (reference)	0.35 [0.32,0.38]	0.42 [0.39,0.45]	0.35 [0.29,0.42]
Ethnicity	Coefficient [95% CIs[3]] p value	Coefficient [95% CIs] p value	Coefficient [95% CIs] p value
White other		-0.15 [-0.20,-0.10] p<0.001	-0.14 [-0.20,-0.09] p<0.001
Mixed ethnicity		-0.09 [-0.15,-0.04] p<0.001	-0.10 [-0.15,-0.05] p<0.001
Indian		-0.50 [-0.55,-0.45] p<0.001	-0.50 [-0.55,-0.45] p<0.001
Pakistani		-0.37 [-0.43,-0.31] p<0.001	-0.38 [-0.44,-0.32] p<0.001
Bangladeshi		-0.14 [-0.24,-0.03] p=0.005	-0.15 [-0.26,-0.05] p=0.003
Other Asian backgrounds		-0.26 [-0.32,-0.19] p<0.001	-0.25 [-0.32,-0.19] p<0.001
Black Caribbean		0.04 [-0.10,0.18] p=0.299	0.03 [-0.11,0.16] p=0.346
Black African		0.15 [0.10,0.20] p<0.001	0.14 [0.09,0.19] p<0.001
Other Black backgrounds		0.05 [-0.07,0.17] p=0.214	0.05 [-0.07,0.17] p=0.199
Chinese		-0.41 [-0.60,-0.22] p<0.001	-0.39 [-0.58,-0.21] p<0.001
Any other ethnic group		-0.04 [-0.15,0.07] p=0.226	-0.04 [-0.15,0.07] p=0.21
Child covariates			
Year of measurement			-0.02 [-0.02,-0.01] p<0.001
School and neighbourhood covariates			
Neighbourhood IMD decile			0.02 [0.01,0.03] p<0.001
RANDOM EFFECTS			
Decomposition of variance			
School level VPC	1.4%	1.0%	0.7%
Neighbourhood level VPC	0.5%	0.3%	0.2%
Child level VPC	98.1%	98.7%	99.1%
MODEL FIT			
Bayesian DIC	85136	84569	84535
Observations	28407	28407	28407

[1] Model with ethnicity only; [2]Model with all retained child, school and neighbourhood covariates [3] Credible intervals

Girls versus boys

Table 3.7 shows the coefficients, decomposition of variance and model fit values for reception year children, by sex.

In reception year, ethnic group differences were similar for girls and boys. Children from White other, mixed, Indian, Pakistani, Bangladeshi, other Asian and Chinese groups had a lower zBMI compared to the White British reference group (Model 1,Table 3.7). As with the non-stratified model, Black African children were the only group to have a consistently higher zBMI in this age group. Mean zBMI was higher by 0.12 [0.06, 0.19] p<0.001 for girls and 0.18 [0.11, 0.25] p<0.001 for boys respectively (model 1). This remained similar after the adjusting for year of measurement and neighbourhood IMD (0.11 [0.04, 0.17] p=0.001 for girls and 0.17 [0.1, 0.24] p<0.001 for boys in model 2).

In reception year girls and boys models, year of measurement and neighbourhood IMD were again retained in final models. Year of measurement was again negatively correlated with zBMI, indicating a decline in zBMI over time for both girls and boys (a decline in zBMI of -0.01 [-0.02,-0.01] p=0.001 for girls and -0.02 [-0.03,-0.01] p<0.001 for boys per year in model 2), whilst neighbourhood deprivation remained positively associated with zBMI for both girls and boys, after controlling for ethnicity (an increase in zBMI of 0.03 [0.02,0.04] p<0.001 for girls and 0.02 [0.01,0.03] p<0.001 for boys per IMD decile in model 2).

The introduction of interaction terms between ethnicity and neighbourhood IMD improved the model fit only for boys (Model 3, Table 3.7). Significant interactions with neighbourhood deprivation were observed for boys from Bangladeshi, Black African and mixed ethnic backgrounds. For Bangladeshi and Black African children, these significant interactions resulted in a negative relationship between deprivation and zBMI i.e. the sum of the coefficient for neighbourhood

IMD (0.02) with interaction terms for these two groups (-0.07 and -0.05 respectively) results in negative coefficients of -0.05 and -0.03, indicating a negative correlation between neighbourhood IMD and zBMI for these two groups (a decline in zBMI per increase in IMD decile). For Bangladeshi boys, adjusting for this interaction explained the significantly lower zBMI observed in this group compared to White British, so it was no longer significant; suggesting that a high number of children from deprived backgrounds was responsible for the low zBMI observed in this group. It is important to note that the improvement in model fit was very small with the addition of interaction terms (a difference in DIC of 6), so caution must be applied to this finding.

Table 3.7 Regression coefficients and variance partition coefficients for school and neighbourhood for models 0 to 3, reception year girls and boys

	Girls			Boys			
	Null model	**Model 1** [1]	**Model 2** [2]	**Null model**	**Model 1** [1]	**Model 2** [2]	**Model 3** [3]
FIXED EFFECTS							
White British (reference)	0.34 [0.31,0.37]	0.41 [0.38,0.45]	0.29 [0.21,0.38]	0.36 [0.32,0.39]	0.43 [0.39,0.46]	0.38 [0.30,0.47]	0.37 [0.28,0.46]
Ethnicity		Coefficients [95% CIs[4]] p value	Coefficients [95% CIs] p value		Coefficients [95% CIs] p value	Coefficients [95% CIs] p value	Coefficients [95% CIs] p value
White other		-0.16 [-0.23,-0.08] p<0.001	-0.15 [-0.23,-0.07] p<0.001		-0.14 [-0.21,-0.06] p<0.001	-0.13 [-0.21,-0.05] p<0.001	0.00 [-0.31,0.30] p=0.49
Mixed ethnicity		-0.11 [-0.18,-0.03] p=0.002	-0.11 [-0.18,-0.04] p=0.001		-0.07 [-0.15,0.00] p=0.034	-0.08 [-0.15,-0.00] p=0.019	-0.53 [-0.79,-0.26] p<0.001
Indian		-0.47 [-0.54,-0.41] p<0.001	-0.47 [-0.54,-0.41] p<0.001		-0.53 [-0.60,-0.46] p<0.001	-0.53 [-0.60,-0.46] p<0.001	-0.50 [-0.68,-0.31] P< 0.001
Pakistani		-0.30 [-0.39,-0.21] p<0.001	-0.32 [-0.40,-0.23] p<0.001		-0.43 [-0.52,-0.35] p<0.001	-0.45 [-0.53,-0.36] p<0.001	-0.47 [-0.80,-0.14] p=0.003
Bangladeshi		-0.14 [-0.28,0.01] P=0.031	-0.16 [-0.30,-0.01] p=0.016		-0.15 [-0.30,0.00] p=0.025	-0.17 [-0.33,-0.02] p=0.014	0.39 [-0.18,0.96] p=0.088
Other Asian backgrounds		-0.28 [-0.38,-0.19] p<0.001	-0.29 [-0.38,-0.20] p<0.001		-0.22 [-0.32,-0.13] p<0.001	-0.23 [-0.32,-0.13] p<0.001	-0.09 [-0.45,0.28] p=0.323
Black Caribbean		0.08 [-0.12,0.28] p=0.216	0.07 [-0.13,0.26] p=0.257		0.01 [-0.18,0.20] p=0.486	-0.01 [-0.20,0.18] p=0.465	0.03 [-0.76,0.82] p=0.469
Black African		0.12 [0.06,0.19] P<0.001	0.11 [0.04,0.17] p<0.001		0.18 [0.11,0.25] p<0.001	0.17 [0.10,0.24] p<0.001	0.61 [0.25,0.98] p<0.001
Other Black backgrounds		0.14 [-0.03,0.30] p=0.053	0.12 [-0.04,0.29] p=0.07		-0.02 [-0.20,0.15] p=0.408	-0.02 [-0.20,0.15] p=0.392	0.73 [-0.27,1.72] p=0.078
Chinese		-0.34 [-0.60,-0.09] p=0.002	-0.33 [-0.58,-0.08] p=0.005		-0.48 [-0.77,-0.20] p<0.001	-0.46 [-0.75,-0.18] p=0.002	-0.82 [-1.49,-0.15] p=0.009
Any other ethnic group		-0.14 [-0.29,0.01] p=0.033	-0.15 [-0.30,-0.01] p=0.022		0.07 [-0.10,0.23] p=0.214	0.06 [-0.10,0.22] p=0.231	0.46 [-0.17,1.09] p=0.074
Child covariates							
Year of measurement			-0.01 [-0.02,-0.01] p=0.001			-0.02 [-0.03,-0.01] p<0.001	-0.02 [-0.025,-0.01] p<0.001

	Girls			Boys			
	Null model	**Model 1 [1]**	**Model 2 [2]**	**Null model**	**Model 1 [1]**	**Model 2 [2]**	**Model 3 [3]**
School and neighbourhood covariates							
Neighbourhood IMD decile			0.03 [0.02,0.04] p<0.001			0.02 [0.01,0.03] p<0.001	0.02 [0.01,0.03] p<0.001
Interaction terms							
White Other X IMD							-0.02 [-0.05,0.02] p=0.195
Mixed Ethnicity X IMD							0.06 [0.03,0.09] p<0.001
Indian X IMD							-0.01 [-0.03,0.02] p=0.364
Pakistani X IMD							0.00 [-0.04,0.04] p=0.458
Bangladeshi X IMD							-0.07 [-0.13,0.00] p=0.019
Other Asian Backgrounds X IMD							-0.02 [-0.06,0.03] p=0.207
Black Caribbean X IMD							-0.01 [-0.10,0.09] p=0.457
Black African X IMD							-0.05 [-0.09,-0.01] p=0.007
Other Black Backgrounds X IMD							-0.09 [-0.20,0.026] p=0.067
Chinese X IMD							0.06 [-0.040,0.15] p=0.131
Any Other Ethnic Group X IMD							-0.05 [-0.12,0.02] p=0.097
RANDOM EFFECTS							
Decomposition of variance							
School level VPC	1.4%	1.1%	0.7%	1.4%	0.8%	0.7%	0.7%
Neighbourhood level VPC	0.6%	0.4%	0.3%	0.4%	0.3%	0.3%	0.3%
Child level VPC	98.0%	98.5%	99.0%	98.2%	98.9%	99.0%	99.0%

	Girls			Boys			
	Null model	**Model 1** [1]	**Model 2** [2]	**Null model**	**Model 1** [1]	**Model 2** [2]	**Model 3** [3]
MODEL FIT							
Bayesian DIC	40438	40179	40161	44696	44379	44357	44351
Observations	13828	13828	13828	14579	14579	14579	14579

[1]Model 1 = Ethnicity only;
[2]Model 2 = model 1 + all other retained covariates;
[3]Model 3 = model 2 + retained interaction terms
[4]Credible intervals

3.3.3.3.2 Year 6

Table 3.8 shows the coefficients, decomposition of variance and model fit values for year 6 children.

In year 6 children, Indian, Pakistani and Chinese groups and those from other ethnic backgrounds had a significantly lower zBMI compared to White British children (Model 1, Table 3.8). Children from White other, mixed and other Asian backgrounds did not differ significantly from White British children. Children from Black Caribbean (an increase in zBMI of 0.20 [0.04,0.36] p=0.005), Black African (an increase in zBMI of 0.17 [0.10,0.24] p<0.001) and other Black backgrounds (an increase in zBMI of 0.34 [0.15,0.53] p<0.001), and those from Bangladeshi backgrounds (an increase in zBMI of 0.25 [0.13,0.37] p<0.001), had a significantly higher zBMI compared to White British children (Model 1, Table 3.8). These findings remained similar after adjustment for child, school and neighbourhood factors (sex and neighbourhood IMD) (Model 2, Table 3.8).

There was a significant effect of sex upon zBMI in year 6 (Model 2, Table 3.8), with boys having a higher zBMI than girls (an increase in zBMI of 0.14 [0.11,0.17] p<0.001 compared to girls). Neighbourhood deprivation was positively associated with zBMI, after controlling for ethnicity (an increase in zBMI of 0.03 [0.02,0.04] p<0.001 per IMD decile in model 2). Age, year of measurement and school characteristics did not contribute to the predictive power of models so were not retained in the final models. The inclusion of interaction terms between ethnicity X sex and ethnicity X neighbourhood IMD showed that there was no difference in these relationships across ethnic groups in year 6, and so the interaction terms were also not retained in the final models.

Table 3.8 Regression coefficients and variance partition coefficients for school and neighbourhood for models 0 to 2, year 6

	Null model	**Model 1 [1]**	**Model 2 [2]**
FIXED EFFECTS			
White British (reference)	0.52 [0.50,0.55]	0.52 [0.49,0.55]	0.27 [0.20,0.33]
Ethnicity	Coefficients [95% CIs[3]] p value	Coefficients [95% CIs] p value	Coefficients [95% CIs] p value
White other		0.06 [-0.01,0.13] p=0.053	0.04 [-0.030,0.12] p=0.123
Mixed ethnicity		0.06 [-0.01,0.12] p=0.057	0.04 [-0.02,0.11] p=0.099
Indian		-0.14 [-0.19,-0.08] p<0.001	-0.14 [-0.20,-0.08] p<0.001
Pakistani		-0.07 [-0.14,0.01] p= 0.047	-0.09 [-0.16,-0.01] p=0.012
Bangladeshi		0.25 [0.13,0.37] p<0.001	0.23 [0.10,0.35] p<0.001
Other Asian backgrounds		-0.04 [-0.13,0.05] p=0.184	-0.05 [-0.14,0.03] p=0.109
Black Caribbean		0.20 [0.04,0.36] p=0.005	0.19 [0.03,0.35] p=0.010
Black African		0.17 [0.10,0.24] p<0.001	0.15 [0.08,0.22] p<0.001
Other Black backgrounds		0.34 [0.15,0.53] p<0.001	0.32 [0.13,0.51] p<0.001
Chinese		-0.31 [-0.60,-0.014] p= 0.018	-0.31 [-0.60,-0.02] p=0.018
Any other ethnic group		-0.15 [-0.31,0.01] p=0.040	-0.16 [-0.32,-0.01] p=0.023
Child covariates			
Sex (Male)			0.14 [0.11,0.17] p<0.001
			School and neighbourhood covariates
Neighbourhood IMD decile			0.03 [0.02,0.04] p<0.001
RANDOM EFFECTS			
Decomposition of variance			
School level VPC	0.7%	0.6%	0.4%
Neighbourhood level VPC	0.5%	0.5%	0.3%
Child level VPC	98.8%	98.9%	99.3%
MODEL FIT			
Bayesian DIC	84036	83955	83865
Observations	25763	25763	25763

[1]Model 1 = Ethnicity only;
[2]Model 2 = model 1 + all other retained covariates
[3] Credible intervals

Girls versus boys

Table 3.9 shows the coefficients, decomposition of variance and model fit values for year 6 children for girls and boys separately.

Ethnic differences in zBMI differed considerably by sex in year 6. For girls, most South Asian groups (with the exception of Bangladeshi children) had a significantly lower zBMI than White British girls in final models, as well as Chinese and those from other ethnic backgrounds. For boys, there were no groups that showed a significantly lower zBMI compared to White British children. The groups with a high zBMI also differed: for girls, children from Black ethnic groups (African, Caribbean and other Black backgrounds) had a significantly higher zBMI (zBMI was higher by 0.19 [0.09,0.29] $p<0.001$; 0.41 [0.19,0.64] $p<0.001$ and 0.41 [0.14,0.68] $p=0.001$ respectively for model 1), whilst for boys, children from Bangladeshi, Black African, White other, Black other and mixed backgrounds showed a significantly higher zBMI (zBMI was higher by 0.33 [0.16,0.50] $p<0.001$; 0.17 [0.08,0.27] $p<0.001$; 0.17 [0.07,0.27] $p<0.001$; 0.27 [0.00,0.55] $p=0.024$; and 0.11 [0.02,0.20] $p=0.01$ respectively for model 1).

Both school and neighbourhood IMD were retained as covariates in the stratified models. As with non-stratified models, neighbourhood deprivation showed a significant relationship with zBMI for girls and boys whilst adjusting for ethnicity (an increase in zBMI by 0.02 [0.01,0.04] $p<0.001$ and 0.02 [0.01,0.03] $p=0.003$ per IMD decile respectively in model 2), whilst school deprivation was significantly correlated with zBMI for girls only (an increase in zBMI by 0.02 [0.01,0.04] $p=0.001$ per IMD decile). Following adjustment for deprivation, coefficients for ethnic groups remained largely similar to the previous model. The exception was that for Pakistani girls and boys, children did not have a significantly lower zBMI in unadjusted models; however after adjustment for deprivation, zBMI became significantly lower compared to white British children for both girls and boys (Model

2, Table 3.9). Year of measurement, age, and other school characteristics other than school IMD did not contribute to the predictive power of models in stratified analysis.

Table 3.9 Regression coefficients and variance partition coefficients for school and neighbourhood for models 0 to 2, year 6 girls and boys

	Girls			Boys		
	Null model	**Model 1 [1]**	**Model 2 [2]**	**Null model**	**Model 1 [1]**	**Model 2 [2]**
FIXED EFFECTS						
White British (reference)	0.46 [0.43,0.50]	0.48 [0.44,0.52]	0.18 [0.09,0.27]	0.59 [0.55,0.62]	0.56 [0.52,0.60]	0.39 [0.30,0.49]
Ethnicity		Coefficients [95% CIs[3]] p value	Coefficients [95% CIs] p value		Coefficients [95% CIs] p value	Coefficients [95% CIs] p value
White other		-0.05 [-0.15,0.05] p=0.171	-0.08 [-0.18,0.03] p=0.072		0.17 [0.07,0.27] p<0.001	0.15 [0.05,0.25] p=0.002
Mixed ethnicity		-0.00 [-0.10,0.10] p=0.49	-0.02 [-0.11,0.08] p=0.368		0.11 [0.02,0.20] p=0.01	0.10 [0.00,0.19] P=0.02
Indian		-0.25 [-0.33,-0.18] p<0.001	-0.26 [-0.34,-0.18] p<0.001		-0.03 [-0.11,0.05] P= 0.215	-0.03 [-0.11,0.04] p= 0.205
Pakistani		-0.08 [-0.19,0.03] p=0.065	-0.13 [-0.23,-0.02] p=0.009		-0.04 [-0.14,0.06] p=0.214	-0.07 [-0.17,0.034] p=0.09
Bangladeshi		0.15 [-0.02,0.32] p=0.046	0.10 [-0.07,0.27] p=0.111		0.33 [0.16,0.50] P<0.001	0.29 [0.12,0.46] p<0.001
Other Asian backgrounds		-0.15 [-0.28,-0.03] p=0.01	-0.17 [-0.30,-0.05] p=0.004		0.06 [-0.06,0.17] p=0.168	0.04 [-0.08,0.16] P=0.251
Black Caribbean		0.41 [0.19,0.64] p<0.001	0.40 [0.17,0.62] p<0.001		0.00 [-0.23,0.23] p=0.496	-0.02 [-0.24,0.21] p=0.437
Black African		0.19 [0.09,0.29] p<0.001	0.14 [0.04,0.23] p=0.004		0.17 [0.08,0.27] p<0.001	0.14 [0.04,0.24] p=0.003
Other Black backgrounds		0.41 [0.14,0.68] p=0.001	0.37 [0.11,0.64] p=0.002		0.27 [0.00,0.55] p=0.024	0.25 [-0.02,0.53] p=0.035
Chinese		-0.60 [-1.07,-0.26] p=0.001	-0.66 [-1.07,-0.26] p=0.001		0.10 [-0.32,0.52] p=0.317	0.10 [-0.31,0.52] p=0.312
Any other ethnic group		-0.24 [-0.46,0.00] p=0.022	-0.28 [-0.50,-0.05] p=0.009		-0.06 [-0.28,0.16] p=0.302	-0.08 [-0.30,0.14] p=0.234
School and neighbourhood covariates						
School IMD decile			0.02 [0.01,0.04] p=0.001			0.01 [-0.01,0.02] p=0.188

	Girls			Boys		
	Null model	**Model 1 [1]**	**Model 2 [2]**	**Null model**	**Model 1 [1]**	**Model 2 [2]**
Neighbourhood IMD decile			0.02 [0.01,0.04] p<0.001			0.02 [0.01,0.03] p=0.003
RANDOM EFFECTS						
Decomposition of variance						
School level VPC	1.4%	1.2%	0.6%	0.4%	0.5%	0.4%
Neighbourhood level VPC	0.2%	0.2%	0.1%	0.7%	0.7%	0.6%
Child level VPC	98.4%	98.6%	99.3%	98.9%	98.8%	99.0%
MODEL FIT						
Bayesian DIC	41352	41272	41254	42615	42591	42585
Observations	12667	12667	12667	13096	13096	13096

[1]Model 1 = Ethnicity only;

[2]Model 2 = model 1 + all other retained covariates

[3] Credible intervals

3.3.3.4 School and neighbourhood effects

Based on goodness of fit, the cross-classified models indicated some degree of clustering at both the school and neighbourhood level, suggesting a meaningful school and neighbourhood effect upon zBMI. However, as shown by the caterpillar plots of the null models (Figure 3.3-Figure 3.6), the extent to which schools and especially neighbourhoods varied was small, and the VPCs were ≤1.5% for both school and neighbourhood across all models, with the large majority of variation in zBMI observed at the individual level.

Based on the VPCs, the effect of school was stronger in reception year compared to year 6; whilst in both year groups, school accounted for a higher amount of the variance than neighbourhood (0.7% and 0.2% in reception; 0.4% and 0.3% in year 6 respectively). A substantial proportion of the 84 schools differed significantly from the total school mean (based on non-overlapping confidence intervals of the residuals), whilst for neighbourhoods, very few of the 197 LSOAs differed significantly from the mean (Figure 3.3-Figure 3.6). The larger school effect in reception year versus year 6 may be partly attributable to two outlying schools (one with a low mean zBMI and one with a high mean zBMI).

Figure 3.3 School effect in reception year (residuals from mean zBMI for each school)

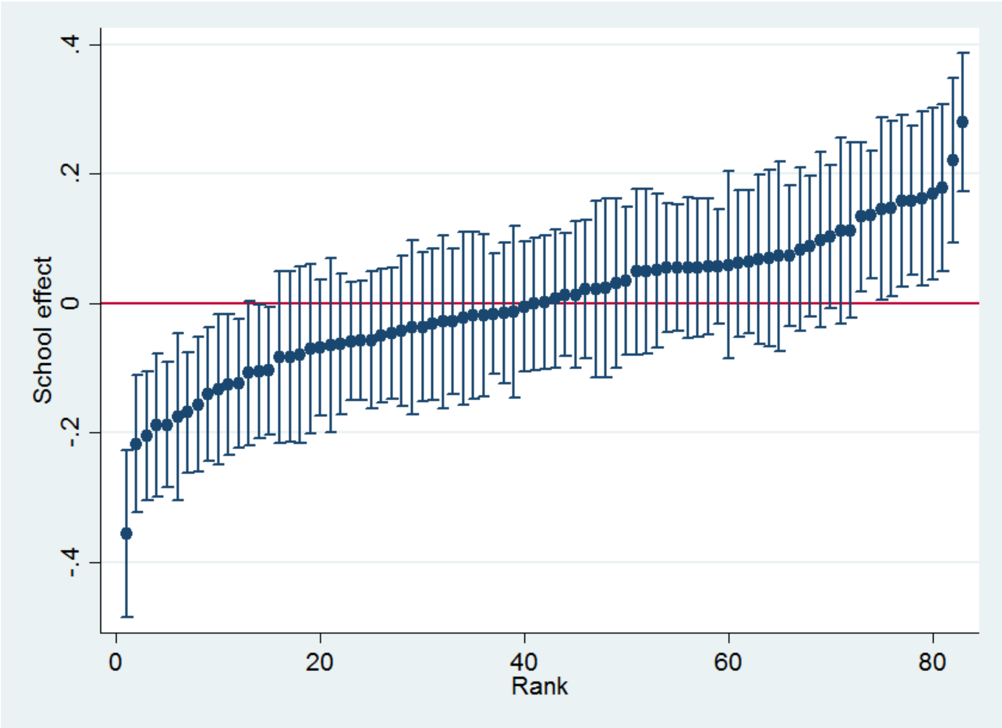


Figure 3.4 Neighbourhood effect in reception year (residuals from mean zBMI for each LSOA)

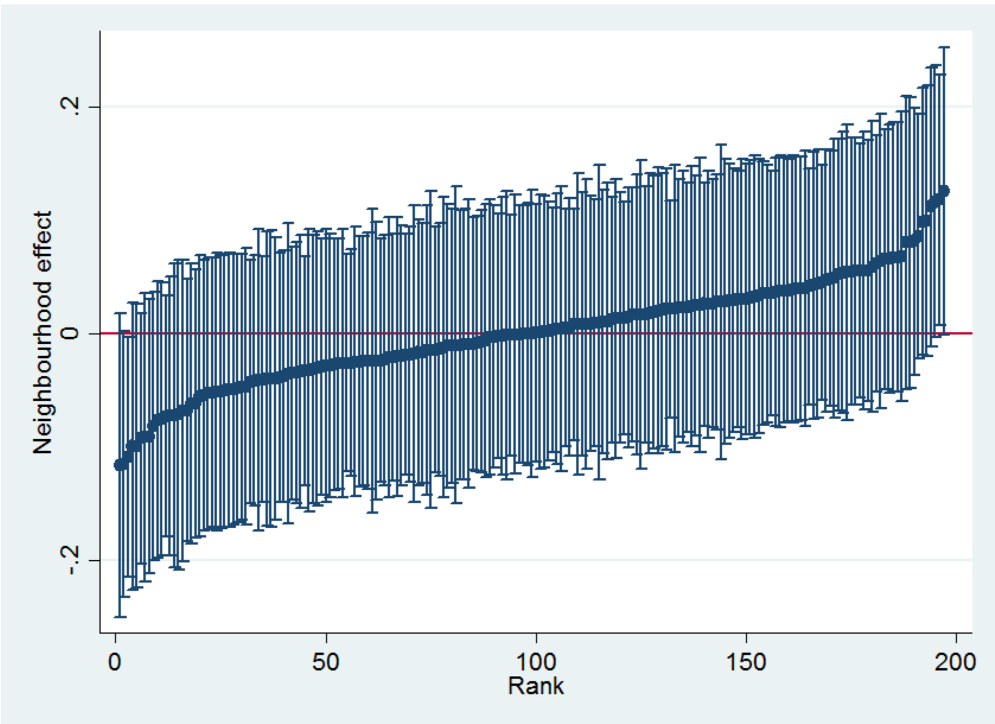


Figure 3.5 School effect in year 6 (residuals from mean zBMI for each school)

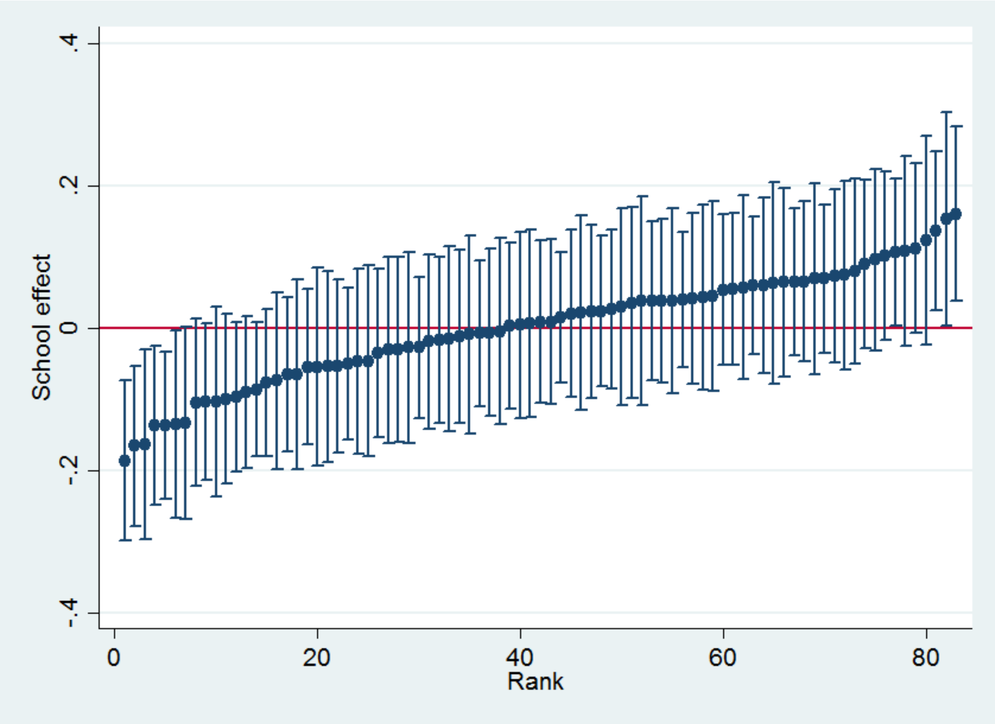


Figure 3.6 Neighbourhood effect in year 6 (residuals from mean zBMI for each LSOA)

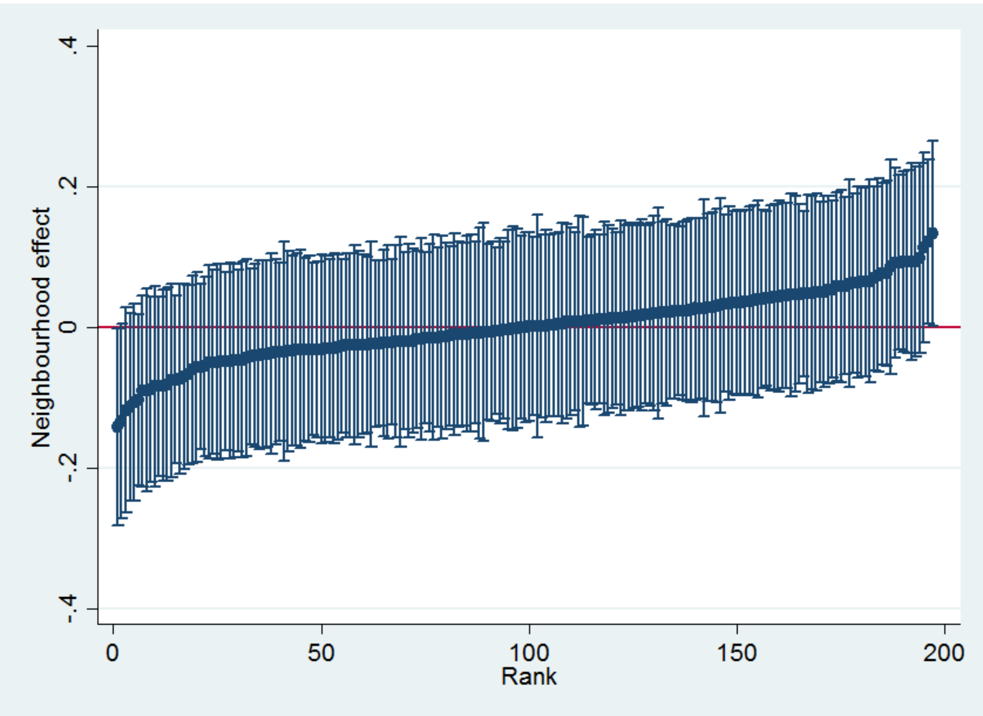


Table 3.10 shows the amount of variation explained by included covariates. The inclusion of ethnicity, year of measurement and neighbourhood IMD accounted for 50% of the variation in zBMI across schools and 60% of the variation across neighbourhoods in reception year; whilst the inclusion of ethnicity, sex and neighbourhood IMD explained 43% and 40% of variation in year 6 across schools and neighbourhoods respectively.

Table 3.10 Percentage variation in zBMI explained by covariates (null versus final model)

		Reception			Year 6		
		All	Girls	Boys	All	Girls	Boys
School	VPC of null model	1.4%	1.4%	1.4%	0.7%	1.4%	0.4%
	VPC of final model	0.7%	0.7%	0.7%	0.4%	0.6%	0.4%
	Variation explained	**50%**	**50%**	**50%**	**43%**	**57%**	**0%**
Neighbourhood	VPC of null model	0.5%	0.6%	0.4%	0.5%	0.2%	0.7%
	VPC of final model	0.2%	0.3%	0.3%	0.3%	0.1%	0.6%
	Variation explained	**60%**	**50%**	**25%**	**40%**	**50%**	**14%**

3.3.3.4.1 Girls versus boys

The school and neighbourhood effects were of a similar magnitude in reception year for both girls and boys, with school accounting for 1.4% of the variation for both groups, and neighbourhood accounting for 0.6% and 0.4% respectively in null models. The inclusion of all retained covariates (ethnicity, year of measurement and neighbourhood IMD) accounted for around half of this variance for girls, whilst for boys they accounted for half of the school-level variance and a quarter of the neighbourhood-level variance (Table 3.10).

Although the school and neighbourhood variance remained small in year 6, for girls, the school effect was more than three times that of boys (1.4% versus 0.4% respectively in null models), whilst for boys, the neighbourhood effect was larger (0.7% for boys versus 0.2% for girls).

The inclusion of ethnicity, school and neighbourhood deprivation did not account for much of the school and neighbourhood variation in zBMI observed in boys in year 6 (0% and 14% respectively), but accounted for around half the variation observed across both schools and neighbourhoods for girls (Table 3.10).

3.3.4 Summary of Part 1

At age 4-5 years, ethnic group differences were similar for boys and girls. Children from South Asian, White other, Chinese and other ethnic groups had a significantly lower zBMI whilst Black African children had a higher zBMI than White British children. At age 10-11 years, boys from other White, Bangladeshi, Black African and mixed groups had a significantly higher zBMI than White British boys. For girls, only children from Black ethnic groups showed a significantly higher zBMI. Year of measurement did not influence ethnic group patterns in zBMI.

The cross-classified models indicated some degree of clustering at both the school and neighbourhood level, suggesting a meaningful school and neighbourhood effect upon zBMI. However, the extent to which schools and especially neighbourhoods varied was small, and the VPCs were <1.5% for both school and neighbourhood across all models, with the large majority of variation in zBMI observed at the individual level. The inclusion of school and neighbourhood characteristics accounted for some of the school and neighbourhood variation in zBMI (up to 60%), but much of the variation remains unexplained.

The exploration of interaction terms for ethnicity and deprivation for reception year boys indicates that the relationship between zBMI and deprivation may differ across ethnic groups. In the current analyses, negative interactions were found with IMD for Bangladeshi and Black African boys in reception year, indicating an inverse relationship between deprivation and zBMI for these groups.

Differences in zBMI across ethnic groups were not explained by individual, school and neighbourhood characteristics.

3.4 Part 2: Ethnic disparities in overweight and obesity

3.4.1 Study aims

This element of the study aimed to answer the following questions:

1. Are there any differences in weight status across ethnic groups, and do these vary by sex or over time?
2. Does the effect of school and neighbourhood characteristics upon weight status vary across ethnic groups?
3. Do school and neighbourhood characteristics account for the differences in weight status seen across ethnic groups?

3.4.2 Methods

The methods used are similar to those detailed in Part 1 however, the outcome was the binary variable overweight or obese (ov/ob) versus not ov/ob, assessed according to population monitoring cut-offs detailed in Part 1 (≥85th centile). Odds ratios (OR) were calculated using the same cross-classified model structure detailed above, but using a logistic regression model instead of a linear regression model. The model was built as described in Part 1.

3.4.3 Results

3.4.3.1 Refining the model

After the addition of (fixed) explanatory covariates, the best-fitting mixed-effects regression model differed for reception year and year 6, and for boys versus girls, resulting in different covariates and interaction terms being retained in the final models. Table 3.11 shows the covariates and interaction terms retained, and more detail on DIC values is provided in Appendix 15. The covariates and interaction terms retained also differed from the linear models described in Part 1.

Table 3.11 Model fitting process (binary models)

	Reception			Year 6		
Covariate	**Whole sample (n = 27,803)**	**Girls (n = 13,524)**	**Boys (n = 14,279)**	**Whole sample (n = 25,763)**	**Girls (n = 12,667)**	**Boys (n = 13,096)**
Ethnicity	Retained	Retained	Retained	Retained	Retained	Retained
Sex	Retained	n/a	n/a	Retained	n/a	n/a
Year of measurement	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped
Age	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped
School IMD	Dropped	Dropped	Dropped	Retained	Retained	Retained
Ofsted rating	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped
School intake	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped
% BME	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped
% ESL	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped
% KS2	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped
Count of takeaways	Dropped	Dropped	Dropped	Dropped	Dropped	Dropped
Neighbourhood IMD	Retained	Retained	Retained	Dropped	Retained	Retained
	n = 28,407	**n = 13,828**	**n = 14,579**	**n = 25,763**	**n = 12,667**	**n = 13,096**
Neighbourhood IMD interaction	Retained	Dropped	Retained	n/a	Dropped	Dropped
School IMD interaction	n/a	n/a	n/a	Dropped	Dropped	Dropped

3.4.3.2 Findings stratified by school year group and sex

3.4.3.2.1 Reception year

Odds ratios of ov/ob with 95% credible intervals and p values for reception year children are displayed in Table 3.12. Decreased odds of ov/ob compared to the White British reference group were found consistently across all models for most South Asian groups, with the exception of Bangladeshi children, and for those from White other and Chinese backgrounds, in reception year. Significantly increased odds of ov/ob were found for Black Caribbean, Black African and Bangladeshi children (an increased odds of ov/ob versus White British by 1.43 [1.09,1.88] p=0.005; 1.42 [1.29,1.57] p<0.001; and 1.23 [0.98,1.53] p=0.037 respectively in model 2). Adjusting for sex and neighbourhood IMD did not account for the difference in odds of ov/ob observed in any groups.

Odds of ov/ob was significantly higher in boys versus girls (increased odds in boys of 1.11 [1.05,1.17] p<0.001 in model 2), and odds of ov/ob increased as neighbourhood IMD increased (1.05 [1.03,1.06] p<0.001). The introduction of interaction terms for ethnicity X neighbourhood IMD (model 3) revealed some variation in the nature of the relationship between ov/ob and neighbourhood IMD by ethnic group. Significant interactions were found for Chinese children and those from mixed backgrounds, indicating that the effect of neighbourhood IMD was greater in these two groups than the White British group (odds of ov/ob increased to a greater extent as IMD increased). Interactions were found for Bangladeshi and Black African children that indicated children from these groups had lower odds of ov/ob as IMD increased. Adjusting for these interactions resulted in significantly lower odds of ov/ob for children from mixed ethnic backgrounds. Adjusting for the decreased odds ov/ob observed in deprived Bangladeshi and Black African groups strengthened the high odds of ov/ob observed in these groups compared to the White British group (increased odds of 2.78 [1.12,6.91] p=0.011 and 3.83 [2.54,5.79] p<0.001 respectively versus white British in model

3). The findings related to differential relationships between deprivation and ov/ob across ethnic groups should be interpreted with caution due to the nature of the small improvement in model fit (an improvement in DIC of 6).

Table 3.12 Odds ratios (of ov/ob) for models 0 to 3, reception year

	Null model	Model 1[1]	Model 2[2]	Model 3[3]
FIXED EFFECTS				
White British: odds of ov/ob	0.3 [0.29,0.32]	0.31 [0.29,0.33]	0.21 [0.19,0.24]	0.2 [0.18,0.23]
Ethnicity		OR [95% CIs[4]] p value	OR [95% CIs] p value	OR [95% CIs] p value
White other		0.84 [0.74,0.96] p=0.006	0.82 [0.73,0.92] p <0.001	0.77 [0.48,1.24] p =0.168
Mixed ethnicity		0.93 [0.83,1.04] p =0.089	0.91 [0.81,1.03] p =0.069	0.59 [0.37,0.93] p =0.013
Indian		0.68 [0.61,0.77] p <0.001	0.68 [0.61,0.77] p <0.001	0.82 [0.59,1.14] p =0.117
Pakistani		0.81 [0.70,0.93] p <0.001	0.78 [0.68,0.90] p <0.001	0.88 [0.44,1.77] p =0.329
Bangladeshi		1.28 [1.03,1.60] p =0.012	1.23 [0.98,1.53] p =0.037	2.78 [1.12,6.91] p =0.011
Other Asian backgrounds		0.75 [0.64,0.89] p <0.001	0.74 [0.64,0.86] p <0.001	1.06 [0.61,1.84] p =0.47
Black Caribbean		1.47 [1.12,1.93] p =0.004	1.43 [1.09,1.88] p =0.005	2.75 [0.87,8.65] p =0.041
Black African		1.48 [1.34,1.64] p <0.001	1.42 [1.29,1.57] p<0.001	3.83 [2.54,5.79] p <0.001
Other Black backgrounds		1.49 [1.17,1.91] p <0.001	1.42 [1.11,1.82] p =0.004	2.82 [0.54,14.6] p =0.102
Chinese		0.58 [0.36,0.94] p =0.009	0.59 [0.36,0.96] p =0.009	0.098 [0.016,0.61] p =0.004
Any other ethnic group		1.09 [0.86,1.38] p =0.238	1.06 [0.84,1.35] p =0.307	0.93 [0.35,2.50] p =0.441
Child level covariates				
Sex (Boys)			1.11 [1.05,1.17] p <0.001	1.11 [1.05,1.17] p <0.001
School and neighbourhood covariates				
Neighbourhood IMD decile			1.05 [1.03,1.06] p <0.001	1.05 [1.04,1.07] p <0.001
Interaction terms				
White other X IMD				1.01 [0.95,1.07] p =0.416
Mixed ethnicity X IMD				1.06 [1.00,1.12] p =0.03
Indian X IMD				0.97 [0.93,1.02] p =0.139
Pakistani X IMD				0.98 [0.91,1.07] p =0.381
Bangladeshi X IMD				0.91 [0.82,1.00] p =0.029
Other Asian backgrounds X IMD				0.95 [0.89,1.02] p =0.074
Black Caribbean X IMD				0.92 [0.81,1.06] p =0.112
Black African X IMD				0.89 [0.85,0.94] P<0.001

	Null model	Model 1[1]	Model 2[2]	Model 3[3]
Other Black X IMD				0.92 [0.77,1.11] p =0.171
Chinese X IMD				1.28 [1.02,1.61] p =0.009
Any other ethnic group X IMD				1.01 [0.90,1.14] p =0.417
MODEL FIT				
DIC	30757	30614	30584	30578
Observations	28407	28407	28407	28407

[1]Model 1 = Ethnicity only;
[2]Model 2 = model 1 + retained child, school and neighbourhood covariates;
[3]Model 3 = model 2 + retained interaction terms
[4]Credible intervals

Girls versus boys

The findings for reception year girls and boys are shown in Table 3.13. For reception year girls, children from Indian and other Asian backgrounds, and those from White other and mixed ethnic backgrounds had a decreased odds of ov/ob compared to the White British ethnic group, which remained consistent after adjustment for neighbourhood deprivation. Girls from Black Caribbean, Black African and other Black backgrounds had significantly increased odds of ov/ob versus White British children in reception year (1.57 [1.05,2.35] p=0.018; 1.38 [1.19,1.59] p<0.001; and 1.68 [1.20,2.35] p=0.002 respectively in model 2).

Boys differed slightly, with Indian, Pakistani and Chinese boys and those from other Asian backgrounds showing decreased odds of ov/ob versus White British boys after adjusting for neighbourhood IMD. Black Caribbean and Black African boys had increased odds of ov/ob versus White British, although this only remained significant for Black African boys after adjustment for neighbourhood IMD (1.47 [1.28,1.68] p<0.001 in model 2). Both boys and girls from Bangladeshi and any other ethnic backgrounds did not differ from the white British group.

Neighbourhood IMD was significantly associated with being ov/ob, with increased odds of ov/ob as IMD increased (1.06 [1.04,1.08] p<0.001 for girls and 1.04 [1.02,1.06] p<0.001 for boys in model 2). There was also a significant interaction between ethnicity and neighbourhood IMD for boys from Black African, Bangladeshi, other Asian, Chinese and mixed ethnic backgrounds. These interaction terms indicated a stronger effect of deprivation for Chinese and mixed ethnicity boys (the increased odds of ov/ob seen in boys with a high IMD was greater than for the White British group); whilst for boys from Black African, Bangladeshi and other Asian backgrounds, there was a decreased odds as IMD increased, compared to the White British group. Adjusting for the significant interaction term resulted in boys from mixed ethnic backgrounds exhibiting significantly lower odds of ov/ob versus the White British group (0.29 [0.16,0.52] p<0.001 in model 3). The inclusion of the interaction terms for boys improved model fit substantially (a improvement in DIC of 20), whereas the inclusion of interaction terms did not improve model fit in girls, so the interaction between ethnicity X neighbourhood IMD observed in the whole sample is likely due to the presence of differential relationships in boys rather than girls in this year group.

Table 3.13 Odds ratios (of ov/ob) for models 0 to 3, reception year girls and boys

	Girls			Boys			
	Null model	**Model 1[1]**	**Model 2[2]**	**Null model**	**Model 1[1]**	**Model 2[2]**	**Model 3[3]**
FIXED EFFECTS							
White British: odds of overweight	0.29 [0.27,0.31]	0.29 [0.27,0.31]	0.2 [0.17,0.23]	0.32 [0.30,0.34]	0.32 [0.30,0.35]	0.25 [0.22,0.29]	0.24 [0.20,0.28]
Ethnicity		OR [95% CIs[4]] p value	OR [95% CIs] p value		OR [95% CIs] p value	OR [95% CIs] p value	OR [95% CIs] p value
White other		0.78 [0.64,0.94] p=0.006	0.75 [0.62,0.91] p =0.001		0.91 [0.77,1.07] p =0.118	0.88 [0.74,1.04] p =0.068	0.83 [0.43,1.58] p =0.305
Mixed ethnicity		0.87 [0.73,1.03] p =0.051	0.85 [0.71,1.01] p =0.034		1.01 [0.86,1.18] p =0.478	0.99 [0.84,1.16] p =0.425	0.29 [0.16,0.52] p <0.001
Indian		0.73 [0.61,0.86] p <0.001	0.73 [0.62,0.86] p <0.001		0.64 [0.54,0.75] p <0.001	0.64 [0.54,0.76] p <0.001	0.73 [0.46,1.14] p =0.091
Pakistani		0.90 [0.74,1.10] p =0.155	0.86 [0.71,1.03] p =0.055		0.73 [0.60,0.88] p <0.001	0.7 [0.57,0.85] p <0.001	1.12 [0.51,2.48] p =0.337
Bangladeshi		1.29 [0.94,1.78] p =0.063	1.21 [0.89,1.64] p =0.109		1.22 [0.90,1.65] p =0.095	1.16 [0.85,1.58] P=0.179	4.74 [1.60,14.0] p =0.011
Other Asian backgrounds		0.70 [0.55,0.89] p =0.001	0.68 [0.54,0.85] p <0.001		0.81 [0.65,1.00] p =0.034	0.8 [0.64,0.98] p =0.019	1.68 [0.84,3.37] P=0.081
Black Caribbean		1.64 [1.09,2.46] p =0.01	1.57 [1.05,2.35] p =0.018		1.36 [0.94,1.97] p =0.048	1.31 [0.90,1.93] P=0.082	1.89 [0.41,8.70] p =0.185
Black African		1.47 [1.27,1.70] p <0.001	1.38 [1.19,1.59] p <0.001		1.54 [1.35,1.77] p <0.001	1.47 [1.28,1.68] p <0.001	3.35 [1.77,6.33] p <0.001
Other Black backgrounds		1.80 [1.29,2.53] p <0.001	1.68 [1.20,2.35] p =0.002		1.25 [0.88,1.76] p =0.108	1.19 [0.84,1.67] P=0.167	3.32 [0.44,25.2] p =0.124
Chinese		0.75 [0.41,1.39] p =0.193	0.76 [0.39,1.49] p =0.207		0.39 [0.17,0.88] p =0.007	0.40 [0.18,0.91] p =0.009	0.00 [0.00,0.20] p =0.001
Any other ethnic group		1.01 [0.73,1.39] p =0.469	0.97 [0.69,1.35] p =0.427		1.18 [0.85,1.63] p =0.165	1.12 [0.81,1.56] p =0.248	2.3 [0.70,7.48] p =0.088
School and neighbourhood covariates							
Neighbourhood IMD decile			1.06 [1.04,1.08] p <0.001			1.04 [1.02,1.06] p <0.001	1.05 [1.02,1.07] p <0.001

	Girls			Boys			
	Null model	**Model 1[1]**	**Model 2[2]**	**Null model**	**Model 1[1]**	**Model 2[2]**	**Model 3[3]**
Interaction terms							
White other X IMD							1.01 [0.93,1.09] p =0.441
Mixed ethnicity X IMD							1.16 [1.09,1.25] p <0.001
Indian X IMD							0.98 [0.92,1.04] p=0.29
Pakistani X IMD							0.94 [0.86,1.04] p=0.134
Bangladeshi X IMD							0.85 [0.75,0.96] p=0.018
Other Asian backgrounds X IMD							0.91 [0.83,0.99] P=0.025
Black Caribbean X IMD							0.96 [0.80,1.14] P=0.299
Black African X IMD							0.91 [0.85,0.98] p=0.003
Other Black X IMD							0.89 [0.71,1.11] p=0.141
Chinese X IMD							1.81 [1.14,2.87] p=0.003
Any other ethnic group X IMD							0.91 [0.80,1.05] p=0.104
MODEL FIT							
DIC	14652	14591	14577	16122	16041	16033	16013
Observations	13828	13828	13828	14579	14579	14579	14579

[1]Model 1 = Ethnicity only;
[2]Model 2 = model 1 + all retained additional covariates;
[3]Model 3 = model 2 + retained interaction terms
[4] Credible intervals

3.4.3.2.2 Year 6

In year 6, ethnic patterns in odds of ov/ob differed to those observed in reception year (Table 3.14). Only Chinese children and those from other ethnic backgrounds showed significantly decreased odds of ov/ob compared to White British children following adjustment for school IMD. Children from most other minority ethnic groups showed significantly higher odds of ov/ob versus White British children. The exceptions were Indian children, who did not differ from White British children after adjustment for sex (model 2), and children from other Asian backgrounds. The significantly increased odds observed in all other ethnic groups remained consistent after adjusting for sex and school IMD.

Sex and school IMD improved model fit, and showed significant associations with odds of ov/ob. Boys had significantly increased odds of ov/ob compared to girls (1.16 [1.10,1.22] $p<0.001$ in model 2) and there was increased odds of ov/ob as school IMD increased (1.05 [1.03,1.06] $p<0.001$ in model 2).

Table 3.14 Odds ratios (of ov/ob) for models 0 to 2, year 6

	Null model	**Model 1[1]**	**Model 2[2]**
FIXED EFFECTS			
White British reference group: odds of overweight	0.53 [0.51,0.56]	0.5 [0.48,0.53]	0.35 [0.32,0.38]
Ethnicity		OR [95% Cis[3]] p value	OR [95% CIs] p value
White other		1.18 [1.05,1.33] p=0.004	1.14 [1.00,1.30] p =0.019
Mixed ethnicity		1.14 [1.02,1.29] p =0.013	1.13 [1.01,1.26] p =0.017
Indian		1.08 [0.98,1.19] p =0.06	1.08 [0.98,1.18] p =0.067
Pakistani		1.24 [1.10,1.41] p <0.001	1.18 [1.04,1.34] p =0.004
Bangladeshi		1.74 [1.42,2.12] p <0.001	1.65 [1.36,2.01] p <0.001
Other Asian backgrounds		1.05 [0.91,1.22] p =0.236	1.03 [0.89,1.20] p =0.335
Black Caribbean		1.32 [1.02,1.73] p =0.02	1.3 [0.99,1.69] p =0.031
Black African		1.42 [1.27,1.59] p <0.001	1.36 [1.21,1.53] p <0.001
Other Black backgrounds		1.5 [1.10,2.06] p =0.004	1.48 [1.07,2.03] p =0.005
Chinese		0.6 [0.34,1.07] p =0.032	0.61 [0.35,1.06] p =0.038
Any other ethnic group		0.81 [0.61,1.09] p =0.082	0.78 [0.59,1.04] p =0.042
Child covariates			
Sex (Male)			1.16 [1.10,1.22] p <0.001
School and neighbourhood covariates			
School IMD decile			1.05 [1.03,1.06] p <0.001
MODEL FIT			
DIC	33202	33150	33109
Observations	25763	25763	25763

[1]Model 1 = Ethnicity only;
[2]Model 2 = model 1 + retained child, school and neighbourhood covariates;
[3] Credible intervals

Girls versus boys

Year 6 girls from Indian, other Asian and Chinese backgrounds had consistently lower odds of ov/ob than the White British group across all models (Table 3.15). After adjusting for school and neighbourhood IMD (model 2), girls from other ethnic groups also had lower odds of ov/ob. Girls from Black Caribbean, Black African and other Black backgrounds and Bangladeshi girls had increased odds of ov/ob (increased odds of 1.72 [1.18,2.50] p=0.004; 1.3. [1.10,1.52] p<0.001; 1.46 [0.94,2.28] p=0.042; and 1.27 [0.95,1.70] p=0.046 respectively in model 2). Pakistani girls also had increased odds of ov/ob but this was no longer significant after adjustment for school and neighbourhood IMD.

Ethnic group patterns differed for year 6 boys. There were no groups with decreased odds of ov/ob versus White British boys. Boys from South Asian groups had higher odds versus White British (1.3 [1.14,1.48] p<0.001 for Indian boys; 1.25 [1.05,1.48] p=0.007 for Pakistani boys; 1.97 [1.50,2.59] p<0.001 for Bangladeshi boys; and 1.32 [1.09,1.60] p=0.003 for boys from other Asian backgrounds). Boys from Black African and other Black backgrounds had increased odds, but this was only significant in Black African boys in final models (1.35 [1.15,1.59] p<0.001). Boys from other White and mixed ethnic groups also had increased odds of ov/ob (1.39 [1.17,1.66] p<0.001 and 1.17 [1.00,1.36] p=0.024 respectively).

School and neighbourhood IMD both improved model fit and showed significant associations with odds of ov/ob for girls and boys, with increased odds as IMD increased.

Table 3.15 Odds ratios (of ov/ob) for models 0 to 2, year 6 girls and boys

	Girls			Boys		
FIXED EFFECTS	**Null model**	**Model 1[1]**	**Model 2[2]**	**Null model**	**Model 1[1]**	**Model 2[2]**
White British reference group: odds of overweight	0.5 [0.47,0.53]	0.49 [0.46,0.52]	0.3 [0.27,0.35]	0.57 [0.54,0.60]	0.51 [0.48,0.54]	0.39 [0.34,0.46]
Ethnicity		OR [95% CIs[3]] p value	OR [95% CIs] p value		OR [95% CIs] p value	OR [95% CIs] p value
White other		0.95 [0.79,1.15] p=0.291	0.89 [0.73,1.07] p =0.114		1.44 [1.22,1.71] p <0.001	1.39 [1.17,1.66] p <0.001
Mixed ethnicity		1.11 [0.94,1.31] p =0.109	1.08 [0.91,1.28] p =0.189		1.19 [1.02,1.39] p =0.012	1.17 [1.00,1.36] p =0.024
Indian		0.87 [0.75,1.01] p =0.041	0.87 [0.75,1.01] p =0.031		1.3 [1.14,1.48] p <0.001	1.3 [1.14,1.48] p <0.001
Pakistani		1.2 [0.99,1.45] p =0.027	1.43 [0.92,1.31] p =0.16		1.31 [1.12,1.55] p =0.001	1.25 [1.05,1.48] p =0.007
Bangladeshi		1.41 [1.07,1.86] p =0.005	1.27 [0.95,1.70] p =0.046		1.43 [1.60,2.80] p <0.001	1.97 [1.50,2.59] p <0.001
Other Asian backgrounds		0.78 [0.61,0.99] p =0.025	0.75 [0.59,0.95] p =0.005		1.35 [1.11,1.65] p <0.001	1.32 [1.09,1.60] p =0.003
Black Caribbean		1.78 [1.24,2.57] p <0.001	1.72 [1.18,2.50] p =0.004		0.98 [0.67,1.43] p =0.467	0.95 [0.65,1.38] p =0.402
Black African		1.43 [1.22,1.69] p <0.001	1.3 [1.10,1.52] p <0.001		1.44 [1.23,1.69] p <0.001	1.35 [1.15,1.59] p <0.001
Other Black backgrounds		1.56 [1.00,2.42] p =0.024	1.46 [0.94,2.28] p =0.042		1.5 [0.94,2.41] p =0.05	1.44 [0.91,2.28] p =0.057
Chinese		0.16 [0.045,0.57] p <0.001	0.17 [0.050,0.55] p <0.001		1.28 [0.62,2.65] p =0.255	1.24 [0.61,2.53] p =0.27
Any other ethnic group		0.71 [0.46,1.09] p =0.056	0.65 [0.43,1.00] p =0.027		0.94 [0.64,1.37] p =0.369	0.88 [0.59,1.32] p =0.276
School and neighbourhood covariates						
School IMD decile			1.04 [1.02,1.07] p <0.001			1.02 [1.00,1.04] p =0.018
Neighbourhood IMD decile			1.03 [1.01,1.05] p <0.001			1.02 [1.00,1.04] p =0.048

MODEL FIT						
DIC	16034	15994	15979	17154	17108	17103
Observations	12667	12667	12667	13096	13096	13096

[1]Model 1 = Ethnicity only;
[2]Model 2 = model 1 + all other retained covariates
[3]Credible intervals

3.4.4 Summary of Part 2

At age 4-5 years, increased odds of ov/ob were found for Black Caribbean, Black African and Bangladeshi children versus the White British group. Ethnic group patterns differed for boys and girls: girls from Black Caribbean, Black African and other Black backgrounds had significantly increased odds of ov/ob versus White British girls, whereas for boys, only Black African boys had increased odds after adjustment for neighbourhood IMD. At age 10-11 years, children from most minority ethnic groups showed significantly higher odds of ov/ob versus White British children, with the exception of Chinese, Indian, any other Asian backgrounds and any other ethnic background. Ethnic group patterns were markedly different for boys and girls: girls from Black backgrounds had increased odds of ov/ob, whilst boys from Black African (and not other Black ethnic groups), South Asian, other White and mixed ethnic groups all had increased odds of ov/ob.

Interactions with neighbourhood IMD were found for boys from Bangladeshi, Black African and other Asian ethnic backgrounds in reception year only, indicating that children from these groups had lower odds of ov/ob as IMD increased.

The introduction of neighbourhood IMD explained the high odds of ov/ob seen in Bangladeshi children and Black Caribbean boys in reception year, and the introduction of school and neighbourhood IMD explained the high odds of ov/ob seen in Pakistani girls and boys from other Black backgrounds in year 6. The introduction of sex explained the high odds of overweight observed in Indian children in year 6.

3.5 Part 3: Measurement considerations

3.5.1 Study aims

This element of the study aimed to answer the following questions:

1. To what extent does height attenuate any differences in zBMI by ethnic group?
2. To what extent do zBMI values adjusted for ethnic variation in body composition influence patterns of ethnic variation observed in childhood zBMI?
3. To what extent does an alternative reference population and cut-offs for classifying child weight status influence patterns of ethnic variation observed in childhood overweight and obesity?

3.5.2 Methods

Three sets of models were fitted to establish the influence of measurement on ethnic group differences in weight status: 1) a linear regression model with zBMI as the outcome and height z-score as an additional predictor variable (to explore the influence of height); 2) a linear regression model with adjusted zBMI as the outcome variable (to explore the influence of body-fat adjusted BMI values); and 3) a logistic regression model with overweight and obesity (ov/ob) as assessed by IOTF reference population and cut-offs as the binary outcome variable (to explore the influence of alternative reference data and cut-offs for assessing weight status). All models were cross-classified multilevel models stratified by year group. The models used were those with all child, school and neighbourhood level covariates included, as detailed in Parts 1 and 2, but not including interaction terms due to the nature of the small improvement in model fit offered by their inclusion (in models not stratified by sex). On this basis, model covariates differed by each year group as detailed in previous sections.

3.5.2.1 Height

The relationship between zBMI and height z-score was first explored using simple linear regression, conducted separately for each year group. Height was then added to the multilevel models detailed in Part 1 to adjust for potential influence of ethnic differences in height upon ethnic differences in zBMI.

3.5.2.2 Adjusted zBMI

Adjusted BMI values for children from South Asian and Black ethnic background produced by Hudda *et al.*, 2017a were used. In this study, the researchers used pooled data from four population-based samples of UK children aged 4-15 years in which total body weight, fat free mass and fat mass were calculated using the deuterium dilution method, alongside standardised measures of height and weight to calculate BMI. Height independent fat mass index (FMI) was derived and sex-stratified regression models were then used to explore ethnic differences in BMI-FMI relationships, in three-year age groups (4.0–6.9, 7.0–9.9 and 10.0–12.9 years).

The authors derived ethnicity adjustments for each age group from the best-fitting regression model coefficients, and adjustment factors were tabulated for each 0.1 kg/m^{-2} BMI increment across the complete BMI range. For South Asian children, BMI adjustments were positive (indicating a higher FMI at lower BMI values), whilst for Black children they were negative (indicating lower FMI for any given BMI value), which is consistent with other literature. For South Asian children, adding 1.1 kg/m^{-2} to the unadjusted BMI values irrespective of age and BMI was adequate to account for ethnic differences in body fat at a given BMI; whilst for Black children, negative adjustments were derived which differed by age and BMI (small adjustments in older children with low BMI values; large adjustments to younger children with high BMI values).

The adjusted factors were added or subtracted to the existing BMI values in the current NCMP data set to derive an adjusted BMI value (AdjBMI) for children from South Asian and Black backgrounds. Adjusted zBMI (Adj zBMI) was calculated from this new AdjBMI value using the *zanthro* command for BMI-for-age (Vidmar *et al.*, 2013) in Stata v14, which calculates BMI z-scores using the LMS method (Cole, 1990; Cole & Green, 1992).

3.5.2.3 IOTF overweight cut-offs

The IOTF reference population is based on nationally representative cross-sectional surveys on growth in children covering the age range 6 – 18 years from six countries (Brazil, Great Britain, Hong Kong, Netherlands, Singapore and the United States) and covering the years 1963 – 1993, with a pooled sample size of ~192,000 (Cole *et al.*, 2000). The associated BMI cut-offs for overweight and obesity are based on adult cut-offs of >25kg/m^2 and >30kg/m^2 at 18 years (using quasi-centile curves constructed to pass through a given BMI cut-off at aged 18 years). Children were categorised into six grades of weight status based on unadjusted BMI values as outlined in Table 3.16 (Cole *et al.*, 2007), using the *zbmicat* command in Stata v14 (Vidmar *et al.*, 2004; Vidmar *et al.*, 2013). These were further refined into two categories for the purpose of analysis: ov/ov and not ov/ob.

Table 3.16 Weight status grades for IOTF cut-offs

Value	**Grade**	**BMI range at 18 years**
-3	Grade 3 thinness	<16 kg/m^2
-2	Grade 2 thinness	16 to <17 kg/m^2
-1	Grade 1 thinness	17 to 18.5 kg/m^2
0	Normal weight	18.5 to <25 kg/m^2
1	Overweight	25 to <30 kg/m^2
2	Obese	30+ kg/m^2

Source: Vidmar *et al.* (2013)

3.5.3 Results

3.5.3.1 Influence of height

Table 3.17 displays the mean height z-scores by ethnic groups for reception and year 6 alongside standard errors (SE). As with zBMI, height z-score was calculated in relation to the UK90 reference population.

Table 3.17 Mean height z-score by ethnic group for reception year and year 6 children

Height z-score	**Reception year**	**Year 6**
	Mean height z-score (SE)	Mean height z-score (SE)
White British	0.02 (0.01)	0.17 (0.01)
White other	0.22 (0.03)	0.32 (0.03)
Mixed ethnicity	0.26 (0.03)	0.36 (0.03)
Indian	0.24 (0.02)	0.39 (0.02)
Pakistani	0.36 (0.03)	0.3 (0.03)
Bangladeshi	0.12 (0.05)	0.11 (0.05)
Other Asian backgrounds	0.02 (0.03)	0.14 (0.04)
Black Caribbean	0.67 (0.07)	0.68 (0.07)
Black African	0.72 (0.02)	0.7 (0.03)
Other Black backgrounds	0.63 (0.06)	0.76 (0.09)
Chinese	-0.05 (0.1)	-0.08 (0.12)
Any other ethnic group	0.08 (0.05)	0.06 (0.07)

Children from Black groups were tallest, whilst those from Chinese groups were shortest. Children from White other, mixed and South Asian groups also tended to be consistently taller than White British children, with the exception of children from Bangladeshi and other Asian backgrounds.

Simple linear regression demonstrated a positive relationship between zBMI and height z-score in both year groups, indicating that zBMI increases as height increases (taller children tend to have a higher zBMI), as shown by the predicted values plotted in Figure 3.7and Figure 3.8.

Figure 3.7 Relationship between zBMI and height z-score, reception year

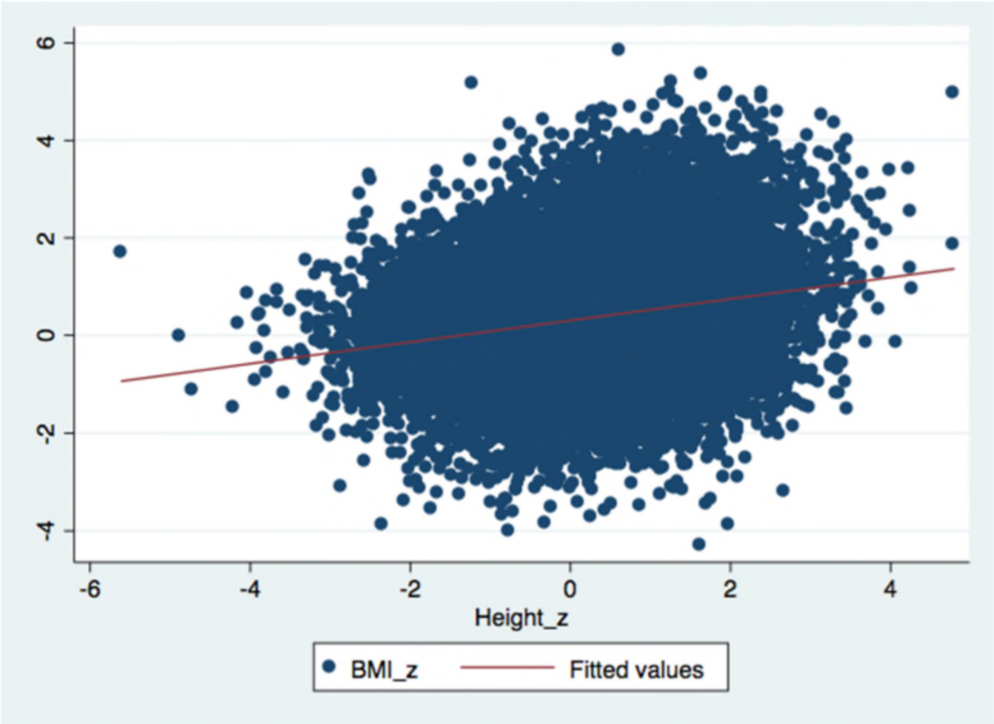
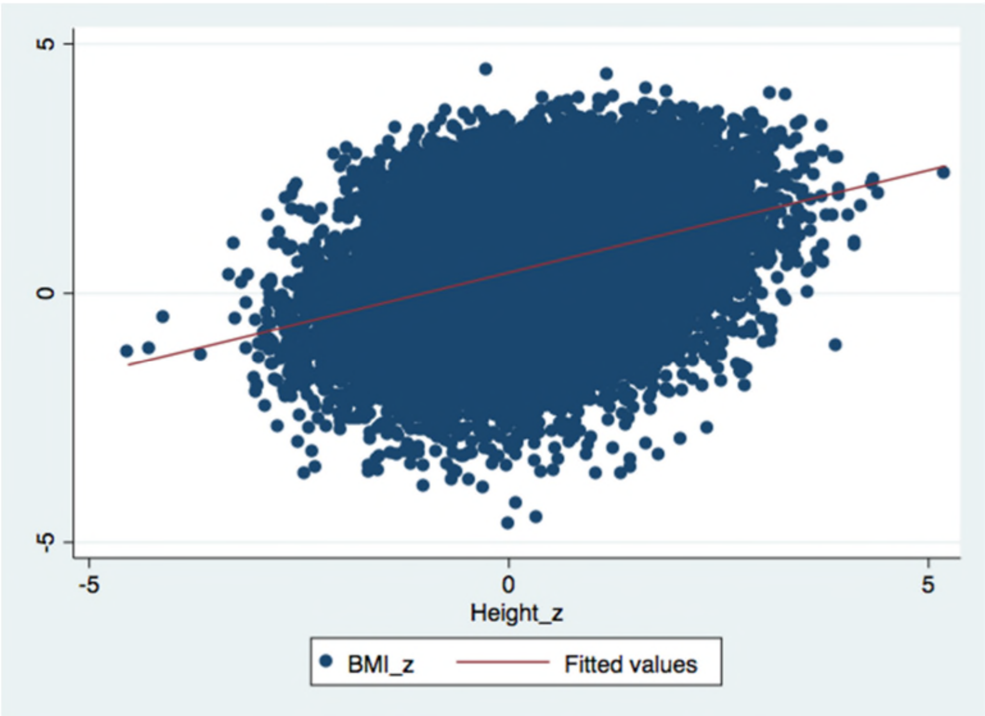


Figure 3.8 Relationship between zBMI and height z-score, year 6



3.5.3.1.1 Reception year

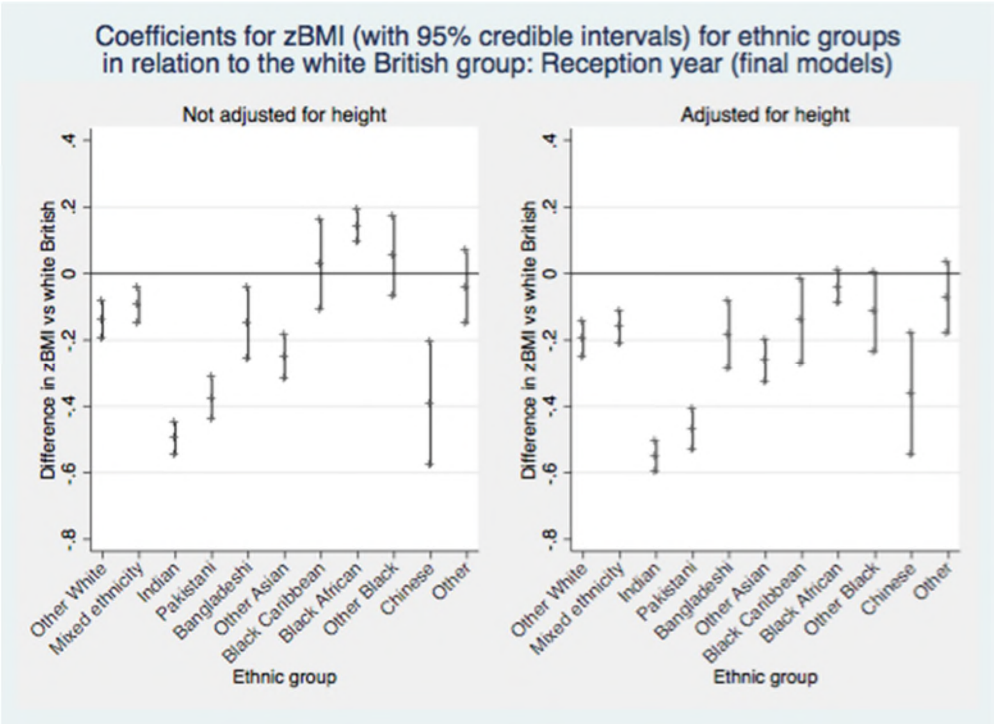
The results of the introduction of height into multilevel models of zBMI are provided in Table 3.18. The findings indicate that for many groups, adjusting for height z-score did little to the nature of ethnic group differences in zBMI. However, for children from Black backgrounds, ethnic group patterns in zBMI differed substantially compared to the unadjusted model. In particular, when not adjusting for height z-score, children from Black African backgrounds had a higher zBMI than the White British reference group, but after adjustment for height z-score, zBMI became significantly lower for this group compared to the White British group (a lower zBMI vs the White British group of -0.04 [-0.09, 0.01] p=0.042). Children from Black Caribbean and other Black backgrounds showed a zBMI that did not differ from the reference group in the unadjusted model, and after introducing height as a covariate, zBMI also became significantly lower (a lower zBMI vs the White British group of -0.14 [-0.27, -0.02] p=0.013; and -0.12 [-0.24, 0] p=0.024 respectively). The inclusion of height z-score substantially improved model fit. The results are presented graphically in Figure 3.9.

Table 3.18 Regression coefficients for ethnic groups relative to the White British reference group: Model adjusted for height versus not adjusted for height, reception year

FIXED EFFECTS	**Not adjusted for height[1]**	**Adjusted for height[2]**
White British reference group	0.35 [0.29, 0.42]	0.33 [0.27, 0.4]
Ethnicity	Coefficient [95% CIs[3]] p value	Coefficient [95% CIs] p value
White other	-0.14 [-0.2, -0.09] p<0.001	-0.2 [-0.25, -0.14] p <0.001
Mixed ethnicity	-0.1 [-0.15, -0.05] p <0.001	-0.16 [-0.22, -0.11] p <0.001
Indian	-0.5 [-0.55, -0.45] p <0.001	-0.55 [-0.6, -0.51] p <0.001
Pakistani	-0.38 [-0.44, -0.32] p <0.001	-0.47 [-0.53, -0.41] p <0.001
Bangladeshi	-0.15 [-0.26, -0.05] p =0.003	-0.19 [-0.29, -0.08] p <0.001
Other Asian backgrounds	-0.25 [-0.32, -0.19] p <0.001	-0.27 [-0.33, -0.2] p <0.001
Black Caribbean	0.03 [-0.11, 0.16] p =0.346	-0.14 [-0.27, -0.02] p =0.013
Black African	0.14 [0.09, 0.19] p <0.001	-0.04 [-0.09, 0.01] p =0.042
Other Black backgrounds	0.05 [-0.07, 0.17] p =0.199	-0.12 [-0.24, 0] p =0.024
Chinese	-0.39 [-0.58, -0.21] p <0.001	-0.37 [-0.55, -0.18] p <0.001
Any other ethnic group	-0.04 [-0.15, 0.07] p =0.21	-0.07 [-0.18, 0.03] p =0.088
Child level covariates		
Year of measurement	-0.01 [-0.02, -0.01] p <0.001	-0.01 [-0.02, -0.01] p <0.001
School and neighbourhood covariates		
Neighbourhood IMD	0.02 [0.01, 0.03] p <0.001	0.02 [0.01, 0.03] p <0.001
Height		
Height z score		0.24 [0.23, 0.25] p <0.001
RANDOM EFFECTS		
Decomposition of variance		
School level VPC	0.7%	1.1%
Neighbourhood level VPC	0.2%	0.3%
Child level VPC	99.1%	98.6%
MODEL FIT		
DIC	84535	82969
Observations	25,763	25,763

[1]Model includes year of measurement and neighbourhood IMD;
[2]Model includes year of measurement, neighbourhood IMD and height z-score
[3]Credible intervals

Figure 3.9 Difference in zBMI for ethnic groups relative to the White British reference group: Model not adjusted for height vs model adjusted for height, Reception year



3.5.3.1.2 Year 6

The introduction of height z-score also substantially improved the model fit in year 6. The mean zBMI of the White British reference group declined after adjusting for height z-score. Relative to the White British group, most groups retained a similar pattern in zBMI in unadjusted and adjusted models, with some exceptions (Table 3.19). As with reception year children, Black African children showed a significantly higher zBMI versus the White British group in the unadjusted model, but after accounting for the influence of height, Black African children showed a lower zBMI in comparison to the White British reference group (a lower zBMI vs White British group by -0.1 [-0.16, -0.03] p=0.001). Height z-score accounted for the high zBMI seen in children from Black Caribbean and other Black backgrounds, so these groups became no longer significantly different to the White British group. A difference was also observed in children from mixed ethnic backgrounds. Prior to adjustment, this group did not differ from White British children;

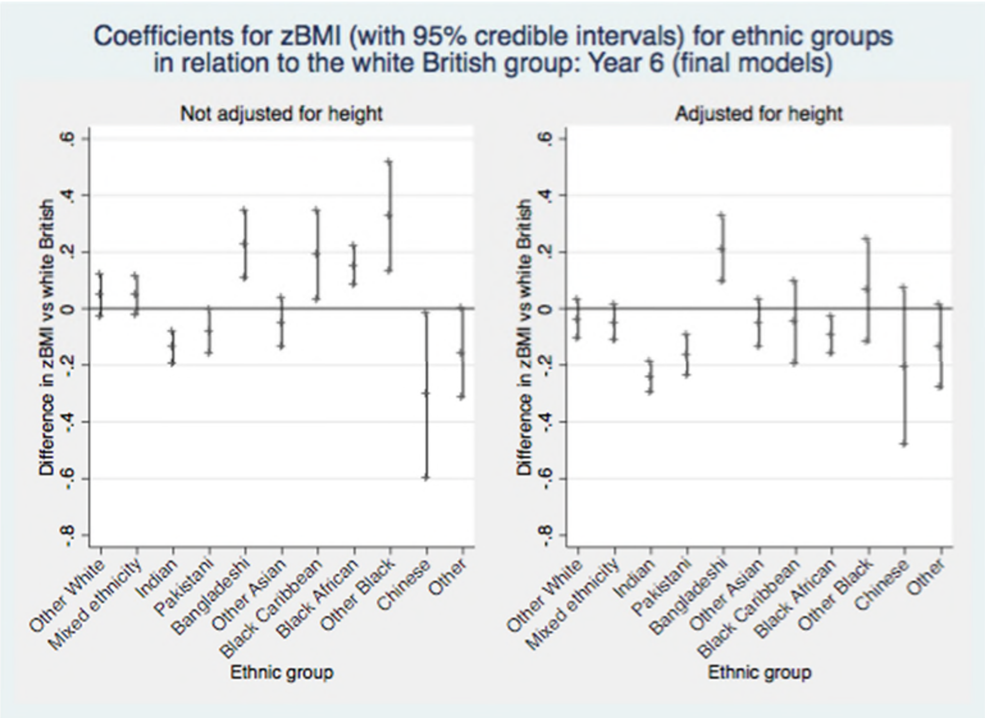
however after adjustment for height z-score, the mean zBMI for this group became significantly lower (a lower zBMI vs White British of -0.05 [-0.12, 0.01] P=0.045). The low zBMI observed in Chinese children in the unadjusted model was also accounted for by the introduction of height z-score. The findings are shown graphically in Figure 3.10..

Table 3.19 Regression coefficients for ethnic groups relative to the White British reference group: Model adjusted for height versus not adjusted for height, year 6

FIXED EFFECTS	**Not adjusted for height[1]**	**Adjusted for height[2]**
White British: reference group	0.27 [0.2, 0.33]	0.15 [0.09, 0.22]
Ethnicity	Coefficient [95% CIs[3]] p value	Coefficient [95% CIs] p value
White other	0.04 [-0.03, 0.12] p=0.123	-0.04 [-0.11, 0.03] p =0.117
Mixed ethnicity	0.04 [-0.02, 0.11] p =0.099	-0.05 [-0.12, 0.01] p =0.045
Indian	-0.14 [-0.2, -0.08] p <0.001	-0.24 [-0.3, -0.19] p <0.001
Pakistani	-0.09 [-0.16, -0.01] p=0.012	-0.17 [-0.24, -0.1] p <0.001
Bangladeshi	0.23 [0.1, 0.34] p <0.001	0.21 [0.09, 0.32] p <0.001
Other Asian backgrounds	-0.05 [-0.14, 0.03] p =0.109	-0.06 [-0.14, 0.03] p =0.091
Black Caribbean	0.19 [0.03, 0.34] p =0.01	-0.05 [-0.19, 0.09] p =0.26
Black African	0.15 [0.08, 0.22] p <0.001	-0.1 [-0.16, -0.03] p =0.001
Other Black backgrounds	0.32 [0.13, 0.51] p =0.001	0.06 [-0.12, 0.24] p =0.244
Chinese	-0.31 [-0.6, -0.02] p =0.018	-0.21 [-0.48, 0.07] p =0.069
Any other ethnic group	-0.16 [-0.32, 0] p =0.023	-0.14 [-0.28, 0.01] p =0.035
Child level covariates		
Sex (Male)	0.14 [0.11, 0.17] p <0.001	0.14 [0.11, 0.16] p <0.001
School and neighbourhood covariates		
Neighbourhood IMD	0.03 [0.02, 0.04] p <0.001	0.03 [0.03, 0.04] p <0.001
Height		
Height z score		0.42 [0.41, 0.43] p <0.001
RANDOM EFFECTS		
Decomposition of variance		
School level VPC	0.4%	0.6%
Neighbourhood level VPC	0.3%	0.3%
Child level VPC	99.3%	99.1%
MODEL FIT		
DIC	83865	80438
Observations	28,407	28,407

[1]Model include sex and neighbourhood IMD;
[2]Model includes sex neighbourhood IMD and height z-score.
[3v]Credible intervals

Figure 3.10. Difference in zBMI for ethnic groups relative to the White British reference group: Model not adjusted for height vs model adjusted for height, Year 6



3.5.3.2 Influence of adjusted BMI values for ethnic Group

Adj zBMI values were generated based on values provided by Hudda *et al.* (2017a) (adjusted for fat mass). Table 3.20 provides mean Adj zBMI values and adjusted proportions of overweight or obese children for each ethnic group for the population, alongside the unadjusted values given in Part 1. As expected from the positive and negative adjustment factors, the adjusted values resulted in a lower mean Adj zBMI and proportion ov/ob for children from Black Caribbean, Black African and other Black backgrounds, and a higher mean Adj zBMI and proportion ov/ob for children from Indian, Pakistani, Bangladeshi and other Asian backgrounds. Population means increased slightly as a result (0.34 in reception year and 0.52 in year 6 using unadjusted values; 0.4 in reception year and 0.58 in year 6 using adjusted values).

Table 3.20 Adjusted zBMI[1] versus unadjusted zBMI - Population means and proportion ov/ob

	Using unadjusted zBMI				Using Adj zBMI			
	Reception		**Year 6**		**Reception**		**Year 6**	
Ethnicity	Mean (SD[2])	% ov/ob (95% CI[3])	Mean (SD)	% ov/ob (95% CI)	Mean (SD)	% ov/ob (95% CI)	Mean (SD)	% ov/ob (95% CI)
White British	0.41 (0.97)	24 (23,24)	0.51 (1.19)	33 (33,34)	0.41 (0.97)	23 (23, 24)	0.51 (1.19)	33 (32, 34)
White other	0.28 (1.07)	21 (19,23)	0.57 (1.24)	37 (34,40)	0.28 (1.07)	21 (19, 23)	0.57 (1.24)	37 (34, 39)
Mixed ethnicity	0.33 (1.11)	23 (21,25)	0.58 (1.26)	37 (34,39)	0.33 (1.11)	23 (21, 25)	0.58 (1.26)	37 (34, 39)
Indian	-0.09 (1.32)	17 (16,19)	0.37 (1.41)	35 (33,37)	0.69 (1.12)	33 (31, 35)	0.83 (1.21)	45 (43, 47)
Pakistani	0.05 (1.29)	20 (18,22)	0.48 (1.44)	39 (37,42)	0.82 (1.1)	38 (36, 41)	0.92 (1.23)	48 (45, 50)
Bangladeshi	0.24 (1.35)	27 (24,32)	0.73 (1.37)	46 (41,50)	0.96 (1.13)	42 (37, 46)	1.13 (1.18)	54 (50, 59)
Other Asian backgrounds	0.17 (1.15)	19 (17,22)	0.5 (1.26)	35 (32,39)	0.92 (0.98)	41 (38, 44)	0.93 (1.09)	47 (43, 50)
Black Caribbean	0.47 (1.14)	32 (26,38)	0.74 (1.2)	41 (35,47)	-0.33 (1.07)	10 (7, 14)	0.39 (1.21)	29 (23, 35)
Black African	0.58 (1.18)	32 (30,34)	0.71 (1.21)	42 (40,45)	-0.22 (1.12)	13 (11, 14)	0.36 (1.21)	30 (28, 33)
Other black backgrounds	0.49 (1.22)	32 (27,38)	0.88 (1.15)	44 (36,52)	-0.3 (1.16)	11 (8, 15)	0.53 (1.16)	35 (28, 43)
Chinese	-0.03 (0.99)	15 (10,22)	0.16 (1.21)	23 (14,34)	-0.03 (0.99)	13 (8, 20)	0.16 (1.21)	23 (14, 34)
Any other ethnic group	0.37 (1.25)	25 (21,30)	0.38 (1.23)	30 (24,36)	0.37 (1.25)	25 (21, 30)	0.38 (1.23)	29 (24, 36)
Total	**0.34 (1.09)**	**23 (23,24)**	**0.52 (1.24)**	**35 (34,36)**	**0.4 (1.06)**	**24 (24, 25)**	**0.58 (1.21)**	**36 (35, 36)**

[1] Adjusted for fat mass
[2] Standard deviation
[3] Confidence intervals

Table 3.21 and Table 3.22 show the results of the fixed effects analysis from multilevel models using the same adjusted models used in Part 1 (with the exclusion of interaction terms) for reception year and year 6, displaying regression coefficients with 95% credible intervals and p values for each ethnic group as compared to the White British reference group. The difference in mean Adj zBMI for each ethnic group versus the White British reference group was plotted alongside plots for mean unadjusted zBMI in Figure 3.11 and Figure 3.12.

Use of adjusted BMI values changed the nature of ethnic group patterns in zBMI in comparison to the white British children in both year groups.

3.5.3.2.1 Reception year

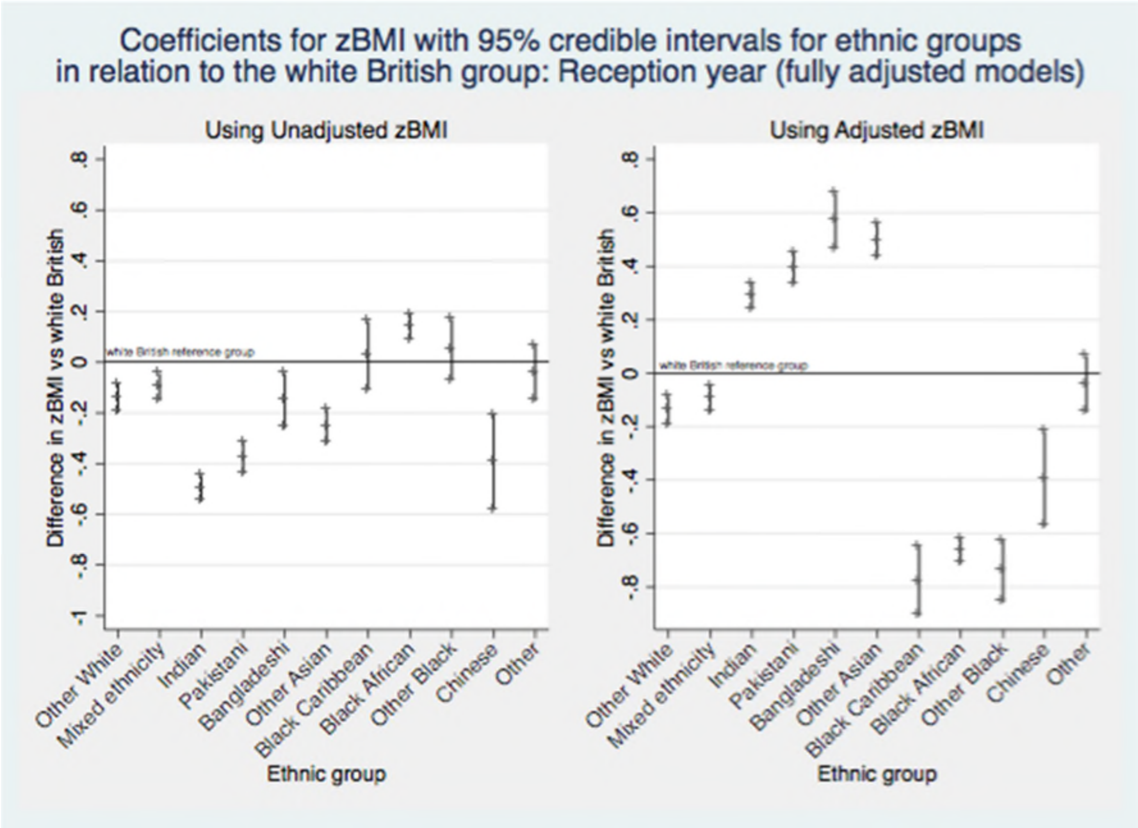
In reception year, using unadjusted values, children from South Asian backgrounds had a significantly lower zBMI compared to White British children, whilst Black African children had a significantly higher zBMI and children from Black Caribbean and other Black backgrounds did not differ from the White British reference group. However, once BMI values were adjusted for fat mass (Table 3.21), children from South Asian groups exhibited a higher Adj zBMI relative to White British children (a higher Adj zBMI versus White British by 0.29 [0.24, 0.33] p<0.001; 0.39 [0.33, 0.45] p<0.001; 0.57 [0.47, 0.67] p<0.001; and 0.49 [0.43, 0.56] p<0.001 respectively for Indian, Pakistani, Bangladeshi and other Asian backgrounds); whilst children from Black backgrounds had a significantly lower Adj zBMI versus white British children (-0.78 [-0.91, -0.65] P<0.001; -0.67 [-0.71, -0.62] P<0.001; and -0.74 [-0.86, -0.63] p<0.001 respectively for Black Caribbean, Black African and other Black backgrounds). This is shown graphically in Figure 3.11.

Table 3.21 Regression coefficients for unadjusted zBMI and Adj zBMI[1] for ethnic groups versus the White British reference group (model 2), reception year

FIXED EFFECTS	**Unadjusted zBMI [2]**	**Adj zBMI [2]**
Reference group		
White British	0.35 [0.29, 0.42]	0.35 [0.29, 0.42]
Ethnicity	Coefficient [95% Cis[3]] p value	Coefficient [95% CIs] p value
White Other	-0.14 [-0.2, -0.09] p<0.001	-0.14 [-0.19, -0.09] p <0.001
Mixed Ethnicity	-0.1 [-0.15, -0.05] p <0.001	-0.1 [-0.15, -0.05] p <0.001
Indian	-0.5 [-0.55, -0.45] p <0.001	0.29 [0.24, 0.33] p <0.001
Pakistani	-0.38 [-0.44, -0.32] p <0.001	0.39 [0.33, 0.45] p <0.001
Bangladeshi	-0.15 [-0.26, -0.05] p =0.003	0.57 [0.47, 0.67] p <0.001
Other Asian Backgrounds	-0.25 [-0.32, -0.19] p <0.001	0.49 [0.43, 0.56] p <0.001
Black - Caribbean	0.03 [-0.11, 0.16] p =0.346	-0.78 [-0.91, -0.65] p <0.001
Black - African	0.14 [0.09, 0.19] p <0.001	-0.67 [-0.71, -0.62] p <0.001
Other Black Backgrounds	0.05 [-0.07, 0.17] p =0.199	-0.74 [-0.86, -0.63] p <0.001
Chinese	-0.39 [-0.58, -0.21] p <0.001	-0.39 [-0.57, -0.22] p <0.001
Any other ethnic group	-0.04 [-0.15, 0.07] p =0.21	-0.04 [-0.15, 0.06] p =0.206

[1] Adjusted for fat mass
[2] Adjusted for year of measurement and neighbourhood IMD
[3] Credible intervals

Figure 3.11 Coefficients for zBMI (unadjusted versus adjusted for fat mass) for ethnic groups relative to the White British reference group, reception year



3.5.3.2.2 Year 6

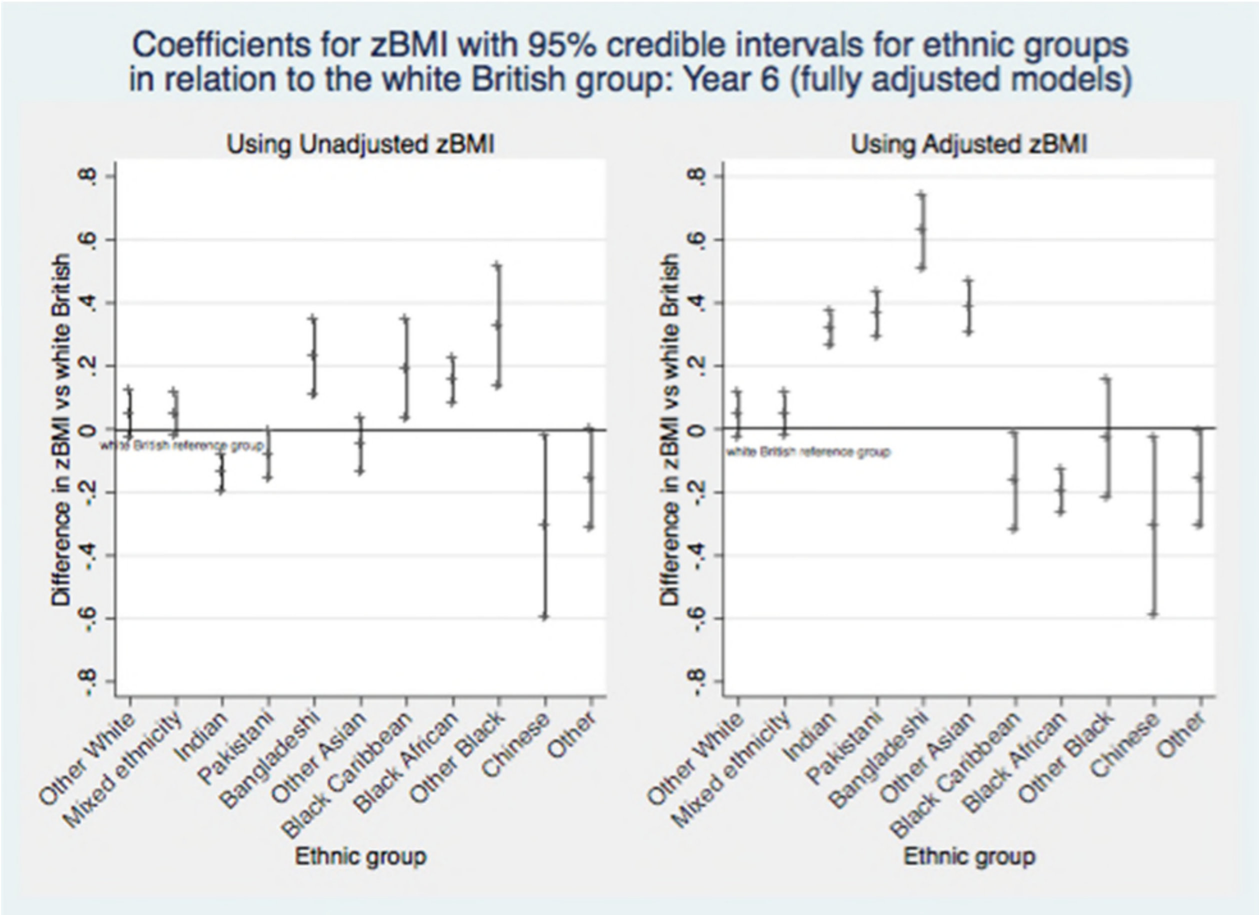
A similar pattern was observed in year 6. Where Indian and Pakistani children previously showed a significantly lower zBMI versus White British children, and those from other Asian background did not significantly differ; when using fat-mass adjusted zBMI values, these groups showed a significantly higher Adj zBMI compared to the White British group (Table 3.22). The Bangladeshi group showed a high zBMI in the original unadjusted model, which remained the case after using Adj zBMI, with the difference in Adj zBMI between this group and the White British group increasing substantially (higher zBMI versus White British by 0.23 [0.1, 0.34] $p<0.001$ in unadjusted models and 0.62 [0.51, 0.74] $p<0.001$ in adjusted models). Where Black Caribbean and Black African children showed a higher zBMI versus White British children in the original model, using fat-mass adjusted zBMI gave these groups a significantly lower Adj zBMI relative to the White British group (lower by -0.17 [-0.32, -0.02] $p=0.015$ and -0.2 [-0.27, -0.13] $p<0.001$ respectively for Black Caribbean and Black African children). Those from other Black backgrounds had a high zBMI in the unadjusted model, but did not differ from the White British group when using Adj zBMI. This is shown graphically in Figure 3.12.

Table 3.22 Regression coefficients for unadjusted zBMI and Adj zBMI[1] for ethnic groups versus the White British reference group (model 2), year 6

FIXED EFFECTS	**Unadjusted zBMI[2]**	**Adj zBMI[2]**
Reference group		
White British	0.27 [0.2, 0.33]	0.27 [0.2, 0.33]
Ethnicity	Coefficient [95% CIs[3]]	Coefficient [95% CIs]
White Other	0.04 [-0.03, 0.12] p=0.123	0.04 [-0.03, 0.11] p =0.116
Mixed Ethnicity	0.04 [-0.02, 0.11] p =0.099	0.04 [-0.02, 0.11] p =0.091
Indian	-0.14 [-0.2, -0.08] p <0.001	0.31 [0.26, 0.37] p <0.001
Pakistani	-0.09 [-0.16, -0.01] p =0.012	0.36 [0.29, 0.43] p <0.001
Bangladeshi	0.23 [0.1, 0.34] p <0.001	0.62 [0.51, 0.74] p <0.001
Other Asian Backgrounds	-0.05 [-0.14, 0.03] p =0.109	0.38 [0.3, 0.47] p <0.001
Black - Caribbean	0.19 [0.03, 0.34] p =0.01	-0.17 [-0.32, -0.02] p =0.015
Black - African	0.15 [0.08, 0.22] p <0.001	-0.2 [-0.27, -0.13] p <0.001
Other Black Backgrounds	0.32 [0.13, 0.51] p =0.001	-0.03 [-0.22, 0.15] p =0.363
Chinese	-0.31 [-0.6, -0.02] p =0.018	-0.31 [-0.59, -0.03] p =0.016
Any other ethnic group	-0.16 [-0.32, 0] p =0.023	-0.16 [-0.31, -0.01] p =0.02

[1] Adjusted for fat mass
[2] Adjusted for sex and neighbourhood IMD
[3] Credible intervals

Figure 3.12 Coefficients for zBMI (unadjusted versus adjusted for fat mass) for ethnic groups relative the White British group, Year 6



3.5.3.3 Influence of an alternative reference population and cut-offs

Table 3.23 shows the differences in the proportion of children classed as overweight or obese when using the two different reference populations and diagnostic criteria (UK90 versus IOTF). The IOTF cut-offs classify a smaller proportion of children as ov/ob compared to the UK90 population monitoring cut-offs.

Table 3.23 Proportion ov/ob in population by ethnic group: UK90 versus IOTF cut-offs

% Ov/Ob	**UK90 Reference**		**IOTF Reference**	
	Reception	**Year 6**	**Reception**	**Year 6**
Ethnicity	% (95% CI[1])	% (95% CI)	% (95% CI)	% (95% CI)
White British	24 (23, 24)	33 (32, 34)	19 (18, 20)	26 (25, 27)
White other	21 (19, 23)	37 (34, 40)	17 (15, 19)	29 (27, 32)
Mixed ethnicity	23 (21, 25)	37 (34, 39)	20 (18, 21)	30 (27, 32)
Indian	17 (16, 19)	35 (33, 37)	16 (14, 17)	28 (26, 29)
Pakistani	20 (18, 22)	39 (37, 42)	17 (16, 19)	33 (31, 35)
Bangladeshi	27 (24, 32)	46 (41, 50)	24 (20, 28)	38 (34, 42)
Other Asian backgrounds	19 (17, 22)	35 (32, 39)	16 (14, 18)	27 (24, 30)
Black Caribbean	32 (26, 38)	41 (35, 47)	28 (23, 34)	33 (27, 39)
Black African	32 (30, 34)	42 (40, 45)	27 (25, 29)	32 (30, 35)
Other black backgrounds	32 (27, 38)	44 (36, 52)	29 (24, 34)	36 (29, 44)
Chinese	15 (10, 22)	23 (14, 34)	13 (8, 20)	20 (12, 31)
Any other ethnic group	25 (21, 30)	29 (24, 36)	23 (19, 27)	24 (19, 30)
Total	**23 (23, 24)**	**35 (34, 36)**	**19 (19, 20)**	**28 (27, 28)**

[1] Confidence intervals

3.5.3.3.1 Reception year

Table 3.24 shows the results of running multilevel models for the binary outcome ov/ob or not ov/ob as classified by IOTF cut-offs for reception year. The odds ratios (OR) for ov/ob for each ethnic group versus the White British reference group are provided alongside the OR obtained using UK90 cut-offs, as detailed in Part 2 of this chapter. Model 2 was used for each year group (adjusted for child, school and neighbourhood covariates but not interaction terms).

Table 3.24 Odds ratios for ov/ob using UK90 vs IOTF cut-offs: model 2, reception year

FIXED EFFECTS	**UK90** [1]	**IOTF** [1]
Reference group		
White British	0.21 (0.19, 0.24)	0.2 (0.17, 0.23)
Ethnicity	OR (95% CIs[2]) p values	OR (95% CIs) p values
White other	0.82 (0.72, 0.92) p <0.001	0.84 (0.73, 0.97) p =0.01
Mixed ethnicity	0.92 (0.81, 1.03) p =0.07	0.99 (0.87, 1.11) p =0.43
Indian	0.69 (0.61, 0.77) p <0.001	0.79 (0.69, 0.89) p <0.001
Pakistani	0.79 (0.68, 0.9) p <0.001	0.84 (0.73, 0.97) p =0.01
Bangladeshi	1.23 (0.98, 1.54) p =0.04	1.3 (1.03, 1.62) p =0.01
Other Asian backgrounds	0.74 (0.63, 0.86) p <0.001	0.76 (0.65, 0.9) p <0.001
Black Caribbean	1.45 (1.09, 1.87) p =0.01	1.64 (1.23, 2.14) p <0.001
Black African	1.42 (1.29, 1.57) p <0.001	1.44 (1.3, 1.59) p <0.001
Other black backgrounds	1.43 (1.11, 1.82) p <0.001	1.55 (1.17, 1.94) p <0.001
Chinese	0.61 (0.36, 0.92) p =0.01	0.69 (0.4, 1.1) p =0.06
Any other ethnic group	1.07 (0.84, 1.36) p =0.31	1.18 (0.91, 1.48) p =0.12

[1]Using model 2, adjusted for sex and neighbourhood IMD
[2] Credible intervals

Ethnic group patterns remained broadly similar when using the different diagnostic criteria for ov/ob. However, for most groups with a higher odds for ov/ob versus the White British group, OR were increased using the IOTF approach, whilst for those with lower odds for ov/ob, the difference relative to the White British group was reduced. Children from mixed ethnic backgrounds no longer had a significantly lower odds of ov/ob when using IOTF cut-offs.

3.5.3.3.2 Year 6

The results of multilevel modelling for the binary outcome ov/ob or not ov/ob for year 6 children are presented in Table 3.25. OR using the new IOTF cut-offs are again presented alongside those using UK90 cut-offs.

Table 3.25 Odds ratios for ov/ob using UK90 vs IOTF cut-offs: model 2, year 6

FIXED EFFECTS	**UK90** [1]	**IOTF** [1]
Reference group		
White British	0.35 (0.32, 0.38)	0.29 (0.26, 0.32)
Ethnicity	OR (95% CIs[2]) p values	OR (95% CIs) p values
White other	1.14 (1.01, 1.29) p=0.02	1.14 (1, 1.3) p =0.03
Mixed ethnicity	1.13 (1.01, 1.26) p =0.02	1.16 (1.03, 1.31) p =0.01
Indian	1.08 (0.98, 1.18) p =0.07	1.08 (0.97, 1.18) p =0.08
Pakistani	1.19 (1.05, 1.34) p <0.001	1.3 (1.14, 1.47) p <0.001
Bangladeshi	1.66 (1.37, 2.01) p <0.001	1.71 (1.38, 2.09) p <0.001
Other Asian backgrounds	1.04 (0.89, 1.2) p =0.34	1.02 (0.87, 1.18) p =0.44
Black Caribbean	1.31 (0.99, 1.7) p =0.03	1.33 (0.99, 1.74) p =0.03
Black African	1.36 (1.2, 1.53) p <0.001	1.24 (1.1, 1.39) p <0.001
Other black backgrounds	1.5 (1.09, 2.04) p =0.01	1.53 (1.09, 2.08) p =0.01
Chinese	0.63 (0.35, 1.03) p =0.04	0.75 (0.36, 1.29) p =0.14
Any other ethnic group	0.79 (0.59, 1.04) p =0.04	0.87 (0.63, 1.15) p =0.16

[1]Using model 2, adjusted for sex and neighbourhood IMD

[2] Credible intervals

As with reception year children, patterns in OR for ethnic groups versus the White British reference group were broadly similar using IOTF cut-offs versus UK90 cut-offs, and OR remained similar in this year group to the UK90 values. However, where children from Chinese and other ethnic groups had significantly lower odds of ov/ob using UK90 cut-offs, when using IOTF cut-offs, these children no longer significantly differed from the White British reference group. Children from Black African groups had slightly reduced odds of ov/ob using IOTF cut-offs versus UK90, but the OR remained high.

3.5.4 Summary of Part 3

Adjusting zBMI for height had an impact on ethnic group patterns for Black ethnic groups in particular, fully accounting for the high zBMI observed in Black groups. The low zBMI observed in Chinese children in the unadjusted model was also accounted for by the introduction of height z-score.

Adjustment for ethnic variation in fat mass by using the BMI adjustment values provided by Hudda *et al.* (2017a) substantially impacted upon ethnic group patterns in zBMI, with children from Black African backgrounds having a significantly lower Adj zBMI compared to the White British group whilst South Asian groups typically had a significantly higher Adj zBMI.

Use of the IOTF approach instead of the UK90 approach did not substantially change ethnic group patterns in odds of ov/ob relative to the White British group, except for Chinese children, and children from mixed ethnic backgrounds (reception) and other ethnic backgrounds (year 6) who no longer had significantly lower odds of ov/ob in year 6.

3.6 Discussion

In Coventry, patterns of zBMI and odds of ov/ob across ethnic groups differed according to age and sex, and analysis revealed variable patterns across sub-groups within broad ethnic categories. However, ethnic group patterns did not vary over time.

There was a small effect of school and neighbourhood upon weight status, and some included school and neighbourhood characteristics explained this variation. Only neighbourhood deprivation was consistently associated with weight status, whilst school deprivation was associated with weight status for year 6 children only. Other included school and neighbourhood covariates, such as school academic performance and concentration of fast food takeaways, were not associated with weight status. Much of the school and neighbourhood variation (40-100%) remained unexplained. Importantly, deprivation did not typically explain ethnic group patterns in childhood weight status.

Ethnic group patterns in child weight status were greatly influenced by metrics of measuring weight status. Adjusting analyses for ethnic group variation in height and body composition (fat mass) changed ethnic group patterns in zBMI. Using alternative reference data and cut-offs resulted in fewer children identified as ov/ob, although ethnic group patterns remained largely similar.

A summary of the findings for each part of the analyses is provided in Table 3.26 (reception year) and Table 3.27 (year 6).

Table 3.26 Summary of findings of all analyses, reception year

Ethnicity	**Unadjusted model: zBMI**	**Adjusted for height: zBMI**	**Adjusted for fat mass: Adj zBMI**	**UK90: Odds of ov/ob**	**IOTF: Odds of ov/ob**
White British (ref group)	0.35 [0.29, 0.42]	0.33 [0.27, 0.4]	0.35 [0.29, 0.42]	0.21 (0.19, 0.24)	0.2 (0.17, 0.23)
	Coefficient (95% CIs[1]) p value	Coefficient (95% CIs) p value	Coefficient (95% CIs) p value	OR (95% CIs) p value	OR (95% CIs) p value
White other	-0.14 [-0.2, -0.09] p<0.001	-0.2 [-0.25, -0.14] p<0.001	-0.14 [-0.19, -0.09] p<0.001	0.82 (0.72, 0.92) p<0.001	0.84 (0.73, 0.97) p=0.01
Mixed ethnicity	-0.1 [-0.15, -0.05] p<0.001	-0.16 [-0.22, -0.11] p<0.001	-0.1 [-0.15, -0.05] p<0.001	0.92 (0.81, 1.03) p=0.07	0.99 (0.87, 1.11) p=0.43
Indian	-0.5 [-0.55, -0.45] p<0.001	-0.55 [-0.6, -0.51] p<0.001	0.29 [0.24, 0.33] p<0.001	0.69 (0.61, 0.77) p<0.001	0.79 (0.69, 0.89) p<0.001
Pakistani	-0.38 [-0.44, -0.32] p<0.001	-0.47 [-0.53, -0.41] p<0.001	0.39 [0.33, 0.45] p<0.001	0.79 (0.68, 0.9) p<0.001	0.84 (0.73, 0.97) p=0.01
Bangladeshi	-0.15 [-0.26, -0.05] p=0.003	-0.19 [-0.29, -0.08] p<0.001	0.57 [0.47, 0.67] p<0.001	1.23 (0.98, 1.54) p=0.04	1.3 (1.03, 1.62) p=0.01
Other Asian backgrounds	-0.25 [-0.32, -0.19] p<0.001	-0.27 [-0.33, -0.2] p<0.001	0.49 [0.43, 0.56] p<0.001	0.74 (0.63, 0.86) p<0.001	0.76 (0.65, 0.9) p<0.001
Black Caribbean	0.03 [-0.11, 0.16] p=0.346	-0.14 [-0.27, -0.02] p=0.013	-0.78 [-0.91, -0.65] p<0.001	1.45 (1.09, 1.87) p=0.01	1.64 (1.23, 2.14) p<0.001
Black African	0.14 [0.09, 0.19] p<0.001	-0.04 [-0.09, 0.01] p=0.042	-0.67 [-0.71, -0.62] p<0.001	1.42 (1.29, 1.57) p<0.001	1.44 (1.3, 1.59) p<0.001
Other Black backgrounds	0.05 [-0.07, 0.17] p=0.199	-0.12 [-0.24, 0] p=0.024	-0.74 [-0.86, -0.63] p<0.001	1.43 (1.11, 1.82) p<0.001	1.55 (1.17, 1.94) p<0.001
Chinese	-0.39 [-0.58, -0.21] p<0.001	-0.37 [-0.55, -0.18] p<0.001	-0.39 [-0.57, -0.22] p<0.001	0.61 (0.36, 0.92) p=0.01	0.69 (0.4, 1.1) p=0.06
Any other ethnic group	-0.04 [-0.15, 0.07] p=0.21	-0.07 [-0.18, 0.03] p=0.088	-0.04 [-0.15, 0.06] p=0.206	1.07 (0.84, 1.36) p=0.31	1.18 (0.91, 1.48) p=0.12

[1] Credible intervals

Table 3.27 Summary of findings of all analyses, year 6

Ethnicity	**Unadjusted model: zBMI**	**Adjusted for height: zBMI**	**Adjusted for fat mass: Adj zBMI**	**UK90: Odds of ov/ob**	**IOTF: Odds of ov/ob**
White British (ref group)	0.27 [0.2, 0.33]	0.15 [0.09, 0.22]	0.27 [0.2, 0.33]	0.35 (0.32, 0.38)	0.29 (0.26, 0.32)
	Coefficient (95% CIs[1]) p value	Coefficient (95% CIs) p value	Coefficient (95% CIs) p value	OR (95% CIs) p value	OR (95% CIs) p value
White other	0.04 [-0.03, 0.12] p=0.123	-0.04 [-0.11, 0.03] p=0.117	0.04 [-0.03, 0.11] p=0.116	1.14 (1.01, 1.29) p=0.02	1.14 (1, 1.3) p=0.03
Mixed ethnicity	0.04 [-0.02, 0.11] p=0.099	-0.05 [-0.12, 0.01] p=0.045	0.04 [-0.02, 0.11] p=0.091	1.13 (1.01, 1.26) p=0.02	1.16 (1.03, 1.31) p=0.01
Indian	-0.14 [-0.2, -0.08] p<0.001	-0.24 [-0.3, -0.19] p<0.001	0.31 [0.26, 0.37] p<0.001	1.08 (0.98, 1.18) p=0.07	1.08 (0.97, 1.18) p=0.08
Pakistani	-0.09 [-0.16, -0.01] p=0.012	-0.17 [-0.24, -0.1] p<0.001	0.36 [0.29, 0.43] p<0.001	1.19 (1.05, 1.34) p<0.001	1.3 (1.14, 1.47) p<0.001
Bangladeshi	0.23 [0.1, 0.34] p<0.001	0.21 [0.09, 0.32] p<0.001	0.62 [0.51, 0.74] p<0.001	1.66 (1.37, 2.01) p<0.001	1.71 (1.38, 2.09) p<0.001
Other Asian backgrounds	-0.05 [-0.14, 0.03] p=0.109	-0.06 [-0.14, 0.03] p=0.091	0.38 [0.3, 0.47] p<0.001	1.04 (0.89, 1.2) p=0.34	1.02 (0.87, 1.18) p=0.44
Black Caribbean	0.19 [0.03, 0.34] p=0.01	-0.05 [-0.19, 0.09] p=0.26	-0.17 [-0.32, -0.02] p=0.015	1.31 (0.99, 1.7) p=0.03	1.33 (0.99, 1.74) p=0.03
Black African	0.15 [0.08, 0.22] p<0.001	-0.1 [-0.16, -0.03] p=0.001	-0.2 [-0.27, -0.13] p<0.001	1.36 (1.2, 1.53) p<0.001	1.24 (1.1, 1.39) p<0.001
Other Black backgrounds	0.32 [0.13, 0.51] p=0.001	0.06 [-0.12, 0.24] p=0.244	-0.03 [-0.22, 0.15] p=0.363	1.5 (1.09, 2.04) p=0.01	1.53 (1.09, 2.08) p=0.01
Chinese	-0.31 [-0.6, -0.02] p=0.018	-0.21 [-0.48, 0.07] p=0.069	-0.31 [-0.59, -0.03] p=0.016	0.63 (0.35, 1.03) p=0.04	0.75 (0.36, 1.29) p=0.14
Any other ethnic group	-0.16 [-0.32, 0] p=0.023	-0.14 [-0.28, 0.01] p=0.035	-0.16 [-0.31, -0.01] p=0.02	0.79 (0.59, 1.04) p=0.04	0.87 (0.63, 1.15) p=0.16

[1] Credible intervals

The key findings are explained in more detail in relation to the existing literature below.

3.6.1 Summary of findings: Weight status across ethnic groups

3.6.1.1 Children from Black backgrounds

Black African children consistently had a high zBMI and increased odds of ov/ob compared to White British children, whilst those from Black Caribbean and other Black backgrounds showed a similar zBMI to White British children in reception year, yet a significantly higher zBMI as children progressed through primary school to year 6. When stratified by sex, only Black African boys had increased odds of ov/ob versus White British across both year groups, whilst for girls, this was the case for all Black groups.

3.6.1.2 Children from South Asian backgrounds

Within the South Asian group, Indian, Pakistani and Bangladeshi groups showed distinct patterns compared to the White British group. Bangladeshi children entered primary school with a lower zBMI versus White British children, but left primary school with a significantly higher zBMI (although this was not the same cohort) and had a higher odds of ov/ob compared to White British children across the two year groups. Similarly, the low zBMI observed in Pakistani children in reception year was also lost in children in year 6, translating to lower odds of ov/ob relative to the White British group in reception year for this group, to higher odds in year 6. Only Indian children maintained a significantly lower zBMI consistently over both year groups. When analysed by sex, boys from Bangladeshi, Pakistani, Indian and other Asian groups all had high odds of ov/ob in year 6, whilst for girls, children from Indian and other Asian backgrounds had lower odds of ov/ob across both year groups, but not Bangladeshi or Pakistani girls.

3.6.1.3 Children from other ethnic backgrounds

Year 6 boys from other White and mixed backgrounds showed a high zBMI and high odds of ov/ob relative to White British children, whilst this was not the case for girls, nor boys in reception year. Girls from any other ethnic group showed a low zBMI consistently across both year groups and low odds of ov/ob in year 6, whilst boys typically did not differ significantly to the White British group. Chinese children were the only group to show a consistently low zBMI and odds of ov/ob compared to White British children (with the exception of year 6 Chinese boys who did not significantly differ to White British children in odds of ov/ob).

3.6.1.4 Comparison to other literature

These ethnic group patterns were similar to those found in the literature in Chapter 2 in highlighting a high BMI or risk of excess weight for Black children, especially Black African children, and Bangladeshi children; and in finding a low BMI or excess weight in Indian children. Detailed analysis of the NCMP in 2007/8 for example, showed a high risk of obesity for Black African, Black Caribbean, Pakistani and Bangladeshi children and low prevalence in Indian and Chinese children after adjustment for IMD, however this analysis combined reception and year 6 children, so age-dependent patterns could not be detected (Townsend & Ridler, 2009). Pallan *et al.* (2014) found that South Asian children broadly showed large increases from reception to year 6. The current analysis has found that this age-related upwards pattern was particularly prominent for the Bangladeshi group within the wider (aggregate) 'South Asian' grouping; and for children from other Black backgrounds within the wider 'Black' grouping. This study therefore adds to the existing research by establishing age dependent patterns across disaggregated ethnic groupings.

The identified sex-related patterns support some of the findings identified in a systematic review by El-Sayed *et al.* (2011) (which did not include NCMP data) in which the authors reported increased risk of obesity in South Asian boys and Black girls and a decreased risk in South Asian girls, relative to Caucasian children. The current analyses used disaggregated ethnic groupings to detect more nuanced and age-related differences.

National analysis of NCMP data suggests inequalities in risk of obesity appear to be widening between Asian children and White children in year 6 over time (Dinsdale *et al.*, 2014), whilst the HSE shows relatively large increases in obesity since 2002 for the largest minority ethnic groups (with the exception of Pakistani) compared to the White English group (Karlsen *et al.*, 2014a). There were no such trends in the current analyses. In reception year, zBMI declined marginally over the seven-year period whilst in year 6 there was no significant change, with no significant interactions between year of measurement and ethnic group. This may be due to the use of year of measurement as a continuous variable, as increases in zBMI year-by-year are very small in year 6. Categorical groupings of time periods may reveal changes over time. It may be the case that in Coventry, zBMI has been relatively stable over time, in contrast to national trends (Public Health England, 2016), and that there has been no widening of ethnic disparities in child zBMI over this time period.

3.6.2 Summary of findings: Influence of school and neighbourhood

3.6.2.1 School and neighbourhood effects

The current analyses suggest a very small effect of school and neighbourhood upon zBMI in primary school children, explaining less than 2% of the variance combined in the null models. Despite the low extent of clustering, school effects appear to be a stronger influence than neighbourhood effects, and school effects appear to be more influential upon zBMI in reception year children versus year 6 children.

3.6.2.2 Role of deprivation

When studying the influence of school and neighbourhood covariates, the study findings reiterate the importance of area deprivation upon weight status. In year 6, both school and neighbourhood measures of deprivation were influential in sex-stratified models. Overall, however, the findings suggest a stronger influence of neighbourhood deprivation.

Adjusting for deprivation typically did not explain ethnic differences in zBMI or weight status, which suggests that there are additional elements that influence ethnic inequalities in childhood weight status. However, the influence of neighbourhood deprivation was not consistent across both zBMI and odds of ov/ob in models when stratified by sex, suggesting some uncertainty in this conclusion. In stratified models using odds of ov/ob, neighbourhood deprivation did explain some of the ethnic group variation in weight status e.g. the high odds of ov/ob observed in Black Caribbean boys in reception and other Black boys and Pakistani girls in year 6 were no longer significantly different to the White British group. For these ethnic groups, high odds of ov/ob may be due to high levels of deprivation rather than other factors related to their ethnicity. This uncertainty suggests that using zBMI instead of weight status measures may hide deprivation effects.

The exploration of interaction terms for ethnicity and deprivation indicates that the relationship between zBMI and deprivation may differ across ethnic groups. Specifically, there was a potential protective effect of neighbourhood deprivation against adiposity for Black African and Bangladeshi boys in reception year.

3.6.2.3 Role of other school and neighbourhood factors

The included school factors had little effect on ethnic group patterns, and much of the school variation remained unexplained, suggesting that much of the variation across schools is influenced by unexplained factors. This is not surprising, since the included school factors were limited. It does not appear to be the case that better performing schools (based on Ofsted and Key Stage 2 tests) have better weight status profiles across their pupils. The current analyses also suggest that concentration of fast food takeaways around primary schools does not influence weight status.

3.6.2.4 Comparison to other literature

The amount of area-level variance was similar to that seen in national analyses by Townsend *et al.* (2012) and Williams *et al.* (2015), yet the amount of variance observed at the school level was substantially lower than that seen in the existing literature (Pallan *et al.*, 2014; Townsend *et al.*, 2012), suggesting that in Coventry, there may be less school clustering compared to other areas. The school-level clustering was more similar to that observed by Williams *et al.* (2015) in their analysis of Devonshire schools, in which the authors concluded that school environment does not significantly affect childhood obesity. This indicates homogeneity across schools in Coventry compared to other areas, which may have greater variation in school characteristics e.g. rural and urban location or where these characteristics have a stronger influence upon zBMI. Despite the low extent of clustering, school effects appear to be a stronger influence than neighbourhood effects, a finding consistent with Townsend *et al.* (2012).

As observed in other analyses of the NCMP (Pallan *et al.*, 2014; Townsend *et al.*, 2012; Williams *et al.*, 2015), school effects appear to be more influential upon weight status in reception year children versus year 6 children. Although this may appear counter-intuitive (a larger effect of school in year 6 might be expected due to greater life-time exposure to the school environment), it may be the case that exposure to contributors at the home and individual levels exert a stronger and more accumulative influence than exposure to school-level factors as children move from early to mid-childhood.

Researchers have debated the extent to which ethnic disparities in childhood obesity in the UK are explained by variation in SES (Falconer *et al.*, 2014a; Karlsen *et al.*, 2014b). The current findings suggest that ethnic variation in weight status is not explained by ethnic variation in deprivation. These findings are consistent with a recent study in which parents of children taking part in the NCMP in London, Sandwell and Somerset were surveyed about their child's diet, physical activity and sedentary behaviours (Falconer *et al.*, 2014a). The researchers found that obesity-related behaviours were more prevalent in children from ethnic minority groups (Asian and Black) at all levels of deprivation, suggesting an independent effect of ethnicity. The exploration of interaction terms for ethnicity and deprivation for reception year boys in the current analyses is consistent with findings from the MCS, which found a potential protective effect of deprivation and low income against adiposity for Black children (Brophy *et al.*, 2009; Martinson *et al.*, 2012), although not Bangladeshi children, as in the current study.

UK studies of the association between fast food takeaway density and childhood obesity have provided mixed findings, with some establishing a positive association in older children and others finding no association (Cetateanu & Jones, 2014; Griffiths *et al.*, 2014; Williams *et al.*, 2015). The current analyses did not find a strong influence of fast food takeaway concentration around schools upon weight status. This may be due to the fact that primary school children have few opportunities to access local shops, have minimal spending power and experience greater parental control over eating patterns, compared to older children. In addition, fast food takeaway density around the child's home may have a greater influence over zBMI than that around the school. Williams *et al.* (2015) found a positive association between the concentration of fast food takeaways around the child's home and zBMI (difference in zBMI in low density versus high density was 0.12; 95% CI: 0.04, 0.20).

Finally, there may be additional school and neighbourhood factors that explain the remaining school and neighbourhood variance in weight status that were not explored in the current analyses. For example, Pallan *et al.* (2014) found a significant inverse relationship between minutes of provision of physical education and zBMI, however, no such measures of physical activity provision were available for these analyses. Other potential explanatory school characteristics that were missing include Healthy Schools Award status, school meals take-up, school support for active travel and other retail environment characteristics around the school (Harrison *et al.*, 2011a; Williams *et al.*, 2015). The explanatory power of such factors has not been well explored in the literature. The current analyses included only one neighbourhood covariate, which explained 0-60% of the neighbourhood-level variance across models. Other potential contributory neighbourhood factors include concentration of fast food takeaways, access to green space, presence of main roads, and access to leisure facilities (Gordon-Larsen *et al.*, 2005; Lovasi *et al.*, 2009).

3.6.2.5 Child and family characteristics

The current analyses included a limited number of child-level covariates, accounting for a very small proportion of the child-level variance, restricting investigation of explanations for ethnic variation in child zBMI. There are a number of potential explanations for ethnic differences in weight status, and it is likely that child and family characteristics such as dietary, physical activity and sedentary behaviours, parental smoking, maternal obesity and parenting strategies (Brophy *et al.*, 2009; Eyre *et al.*, 2015c; Falconer *et al.*, 2014a; Higgins, 2008; Higgins & Dale, 2012; Khunti *et al.*, 2007; Martinson *et al.*, 2015; Zilanawala *et al.*, 2015) interact with dynamic cultural, ecological and socio-political contexts to produce ethnic group disparities (Bhopal, 2014; Kumanyika, 2008; Nazroo, 2001; Ochieng, 2013). For example, cultural norms around weight and obesity-related behaviours, perceptions of the local environment and experiences of racism may play a role (Hornby-Turner *et al.*, 2014; Kelly *et al.*, 2012; Trigwell *et al.*, 2015; Trigwell *et al.*, 2014). Associations between BMI and stage of maturation is also of relevance (Daniels *et al.*, 1997; Daniels *et al.*, 2000), with some evidence of ethnic variation in pubertal advancement over childhood and adolescence (Adair & Gordon-Larsen, 2001). It was not possible to explore these potential explanatory factors in the current analysis.

3.6.3 Summary of findings: Measurement

3.6.3.1 Key findings

In the current analyses, height z-score was strongly correlated with zBMI. These height z-score differences fully accounted for the high zBMI observed in Black groups and the low zBMI seen in Chinese children in year 6. Adjustment for height z-score also strengthened the negative association of zBMI with Indian and Pakistani ethnicity.

The use of BMI adjustments based on fat mass measurements provided by Hudda *et al.* (2017a) in the current analyses showed that ethnic group differences in zBMI changed substantially when using fat-mass adjusted zBMI. Once Adj zBMI was used as an outcome, children from Black African backgrounds had a significantly lower Adj zBMI compared to the White British group whilst South Asian groups typically had a significantly higher Adj zBMI.

For the most part, use of the IOTF approach instead of the UK90 approach did not substantially change ethnic group patterns in odds of ov/ob relative to the White British group. The main difference observed when comparing the UK90 and IOTF reference populations was for Chinese children (no longer a significantly lower odds of ov/ob in year 6), which may be due to the IOTF reference population making use of data from a Hong Kong population.

Despite little change in ethnic group patterns when comparing both approaches, the use of the IOTF reference population and cut-offs resulted in an increase in odds of ov/ob versus the White British group for most groups in reception year (less so in year 6), and a decrease in odds for Black African children in year 6. The effect of these changes was to move most South Asian groups in reception year and Black African children in year 6 closer towards a non-significant difference to the White British group, whilst Bangladeshi children increased the magnitude of their higher odds of ov/ob relative to White British group in both year groups. These findings show some consistency with the BMI adjustments explored in the previous section in the direction of their change i.e. BMI (fat mass) adjustments produced a higher zBMI in South Asian children and a lower zBMI in Black children. However, this pattern is not consistent across all groups or across both years. For example, Black African children showed a relative increase in their higher odds in reception year and a relative decrease in their higher odds in year 6, and children from Black Caribbean and other Black groups showed a relative increase in their higher odds of ov/ob in both year groups. The findings suggest that the effect of applying the IOTF reference population and cut-offs is not consistent across ethnic groups (i.e. odds of ov/ob declined in White British children overall but the direction and magnitude of difference between White British and other ethnic groups differed).

3.6.3.2 Comparison to other literature

The findings relating to height are similar to those observed in other studies. Freedman *et al.* (2003) found that BMI preferentially classified tall children as obese, with the strongest correlation found between 9-11 years of age. Ridler *et al.* (2009) similarly found that height attenuated the high odds of excess weight observed in children from Black African backgrounds, and did not account for the high odds of overweight and obesity in Bangladeshi children; a pattern observed in the current study using zBMI (adjusted for height z-score). However, the extent to which such analyses of BMI should control for the effect of height is not clear, and a judgement cannot be made on the basis of the current analysis. Height shows independent positive cross-sectional associations with SFT and insulin, and longitudinally with adult obesity, and was a better predictor of these outcomes than alternative weight-for-height measures such as Ponderal Index (kg/m^3).

Other studies have found that weight-for-height measures underestimate adiposity in South Asian children and overestimate adiposity in Black children (Daniels *et al.*, 1997; Haroun *et al.*, 2010; National Obesity Observatory, 2009; Shaw *et al.*, 2007; Wang, 2002). The results of analysis using BMI adjustments based on fat mass measurements provided by Hudda *et al.* (2017a) are consistent with recommendations for lower BMI cut-offs to indicate risk of diabetes in South Asian adults (National Institute for Health and Care Excellence, 2013), and mimic the national analyses recently conducted by Hudda *et al.* (2017b) in which BMI adjustments revealed extremely high overweight-obesity prevalence among South Asian children and lower overweight-obesity prevalence for Black children, which did not appear in unadjusted analysis.

However, ethnic-group specific adiposity cut-offs are currently not recommended for children (Viner *et al.*, 2010), partly because of caution around distinguishing risk of adiposity using simplistic classifications of ethnicity (i.e. South Asian; Black) and ignoring the role of SES; but also because of a lack of data exploring ethnic differences in metabolic risk related to adiposity in children, as with adults.

The use of the IOTF reference population and cut-offs reduced the overall prevalence of ov/ob in the current population, with the UK90 criteria classifying more children as ov/ob. The findings suggest that fewer children would be classified as overweight or obese using the IOTF approach, and that this reduction may not be consistent across ethnic groups. In their review of the evidence for the application of ethnic-group specific BMI cut-offs for child obesity, Viner *et al.* (2010) found that the IOTF obesity definitions misclassified very few adolescents when verified with body composition and waist circumference, and that the misclassification was similar amongst South Asian and White British adolescents, however a similar review has not been undertaken for children from other ethnic groups.

3.6.4 Strengths and limitations

3.6.4.1 Key strengths

Multilevel modelling techniques were utilised to account for the effect of clustering, providing more robust standard errors around the regression coefficients (Rasbash *et al.*, 2016). Seven years of data were combined to increase the sample base and provide more robust estimates (minimising small number variation), which allowed exploration across disaggregated ethnic groupings. Although there were changes in mean zBMI over the data period in reception year children, this was relatively small (although significant), and zBMI in year 6 children was stable over the time period, suggesting it was appropriate to use aggregated data across the time period. BMI z-score was used, which is more sensitive than prevalence to detect changes over time than BMI alone (Hancock & Dinsdale, 2014).

3.6.4.2 Key limitations

3.6.4.2.1 Included variables

Availability of data limited the covariates that could be included in the modelling. Due to changes in the ownership of the NCMP data from NHS trusts to Local Authority, earlier datasets lacked postcode data that could have been used to generate more neighbourhood level covariates e.g. due to the lack of postcode data in the current analysis, it was not possible to include a measure of fast food takeaway density around the home. Other school level covariates were missing due to lack of access to the data or incomplete data to cover the data period e.g. cessation of the Physical

Education and Sport Strategy for Young People survey and Healthy Schools Award status. Only area-level measures of deprivation were used. Individual or household measures of SEP or parental education may account for some more of the individual-level variation observed and some of the ethnic group differences (as evident in Chapter 2), although use of equivalised household income obtained similar findings to IMD in the HSE (Karlsen *et al.*, 2014a). The current analyses were also limited by the lack of child and family-level covariates. Further exploration of the contributory roles of these child and family-level factors are needed, some of which lend themselves to exploratory qualitative approaches.

3.6.4.2.2 Treatment of variables

Findings may have also differed according to how variables were treated e.g. year of measurement is treated as a continuous variable, and shows no significant relationship to zBMI as increases in zBMI year-by-year are very small. Categorical groupings of time periods may have revealed changes over time. Variation in participation levels and the quality of ethnicity data collection across years of measurement may have also influenced the quality of the analysis, variables that were not adjusted for in this analysis.

There are some limitations to the fast food variable. Firstly is the use of a straight line radius 'buffer', as it does not take into account that pupils may access food beyond this buffer, elsewhere on their journey to school for example; and does not take into account genuine walking routes. Secondly is the format of classification of outlets, which does not distinguish takeaways from sandwich shops (which may differ from one another fundamentally in the menu on offer). Thirdly, the data period for this variable was 2016, which may not be fully reflective of school localities over the earlier years of data collection, and some areas may have changed significantly over time. Unfortunately, it was not possible to obtain historical data for takeaways over the time period studied.

3.6.4.2.3 Mode of analysis

As a cross sectional analysis, differences observed in patterns from reception year to year 6 cannot be interpreted longitudinally, since variation in patterns across year groups may be attributable to a cohort effect. NCMP data collection now includes unique reference numbers that allow tracking of children from reception year to year 6, and this longitudinal data will provide valuable insights into the relationship between early and late childhood weight status going forward.

3.6.4.2.4 Ethnic groupings

Despite efforts to use a large number of ethnic groupings, some aggregation of potentially heterogeneous sub groups was required in order to maintain appropriate sample bases and to simplify regression models, which may disguise within-group differences. Use of any ethnic categorisation is artificial to some extent as it does not necessarily reflect many aspects of an individual's ethnic identity, for example country of birth; ancestry; religion; skin colour; and language. In addition, the NCMP collects ethnicity based on parental report, which may differ to how children see their ethnic identities. Data on generational status related to migration was also lacking. Other research has found, for example, that children of foreign-born Black African and boys of foreign-born Pakistani parents have a higher risk of obesity than those with UK-born parents (Henderson, 2010; Martinson *et al.*, 2015; Smith *et al.*, 2012) (as discussed in Chapter 2). Alongside generational status, degree of acculturation (based on the extent to which individuals adopt the host country's cultural norms) may have an important influence upon ethnic group differences (Delavari *et al.*, 2013), which was not captured in the current analyses. On this basis, the current analyses is limited in its ability to determine differences between distinct subgroups, as well as more subtle subgroupings based on concepts of identity, within larger aggregate groupings.

3.6.4.2.5 Metrics of adiposity

The key limitation in the analysis of the influence of measurement factors upon ethnic variation in weight status was the lack of independent body composition or metabolic data in the current study, which limits the conclusions that can be drawn on the basis of this analysis alone. Direct measures of body fat are not routinely collected as part of the NCMP data collection procedure, as they are time-consuming and add additional costs, so it was not possible to verify ethnic group differences in body fat relative to BMI in the current study. In addition, the BMI adjustments developed by Hudda *et al.* (2017a) are based on the relationship of BMI to body composition rather than metabolic risk, which warrants further research. However, body fatness shows a strong relationship to insulin resistance in children (Nightingale *et al.*, 2013), and the authors expect that BMI adjustments for South Asian children would be greater if metabolic sensitivity to body fat was used as the basis for BMI adjustments rather than body fat alone. Adjusting for height z-score is also problematic due to multi-colinearity between BMI and height, since BMI is a function of height.

There are also a number of limitations to the analyses in relation to IOTF reference data and cut-offs. Firstly, it is not clear if the observed differences (between UK90 and IOTF findings) are due to the use of a different reference population, or use of different diagnostic criteria (centile vs adult cut-offs approach). These analyses did not look at the proportion of children classified as overweight by UK90 definitions who were subsequently classified as a not overweight by IOTF definitions (or vice versa). It was also not possible to determine and compare the sensitivity and specificity of the two approaches by verifying the weight status classifications with body composition data. On this basis, a judgement cannot be made on which approach (IOTF versus UK90) has better diagnostic accuracy in identifying overweight or obese children. However, others have observed low sensitivity but high specificity of IOTF cut-offs in identifying overweight and obesity (Scientific Advisory

Committee on Nutrition and the Royal College of Paediatrics and Child Health, 2012).

Despite these limitations, the findings do however highlight some potential problems in the use of BMI and the important role of reference populations and diagnostic cut-offs in understanding ethnic differences in weight status, offering some direction for future research, as detailed below.

3.6.5 Implications

These analyses add to the existing multilevel analyses using NCMP data by stratifying by ethnic group and exploring interactions between ethnicity and deprivation, as recommended by Townsend *et al.* (2012), and through the addition of covariates reflecting school demographics and academic conditions. It has also identified age- and sex-related ethnic group patterns of weight status in children.

Analyses using height-adjusted zBMI, fat mass-adjusted zBMI and alternative reference data and diagnostic cut-offs suggest that the ethnic group patterns of weight status identified in these analyses should be interpreted cautiously, as they may be the result of measurement bias. Although the analyses conducted here are limited in clarifying the existence of measurement bias, it has highlighted the potential policy implications of misidentifying ethnic variation in childhood adiposity.

3.6.5.1 Service design

As encouraged by Dinsdale and Ridler (2012), the comparison of local patterns to regional and national ones assists in the targeting of interventions to tackle unhealthy weight among children, and it would be valuable to replicate the methods used here on other regional, as well as the national, NCMP data sets. The current findings provide information for the local targeting of obesity prevention and treatment services, for example, it may be appropriate to target Black and Bangladeshi families in early primary school in order to minimise risk of excess weight in year 6 children. Although services have traditionally been targeted at those from deprived backgrounds, there is also evidence that for Black and Bangladeshi boys, it may be necessary to reach families from across all deprivation levels. Potential mechanisms for the contrasting relationship between deprivation and zBMI observed in Black and Bangladeshi boys require further exploration.

The study indicates a low level of clustering at school and neighbourhood level. This does not necessarily suggest that school and area-based interventions may be unproductive in reducing childhood obesity, but that efforts that focus on the child and family-based factors may be more effective.

Based on the current findings, the application of an adjustment for ethnic group differences in height to the NCMP data would likely result in fewer children from Black groups being classified as overweight, which would have implications for service design at both a population level and clinical level. Similarly, the use of fat mass-adjusted BMI values (Adj zBMI) would also have implications for clinical settings, for example in correctly identifying a greater number of South Asian children at high risk of adiposity, and misclassifying fewer children from Black groups. This could result in earlier intervention for reducing cardiovascular disease risk for South Asian children, and a reduction in levels of concern experienced by Black children and their families who would otherwise be misclassified as overweight or obese.

Hypothetically, the use of these BMI adjustments (for height or fat mass) in monitoring childhood overweight and obesity using the NCMP would be simple to apply to past and future NCMP data. This could give a more accurate indication of ethnic group disparities in overweight and obesity, with important implications for local and national service design.

If IOTF cut-offs were applied to the NCMP instead of the UK90 approach, the resulting reduction in overweight and obesity prevalence could have implications for service design. The results indicate that this reduction may not be consistent across ethnic groups, which may also influence service design to address ethnic disparities in weight status at a national and local level. However, it is not clear whether this approach would have an effect on the clinical identification of overweight or obese children, as the current analyses only used population-monitoring cut-offs.

3.6.6 Remaining gaps in the literature

Future studies would benefit from the inclusion of multiple metrics of SEP and deprivation at different levels of influence (El-Sayed et al., 2011). The use of ethnicity-based adjustments for BMI (by height or fat mass), or ethnic-group specific cut-offs for overweight and obesity requires further investigation in children, to establish the extent to which ethnic group differences in weight status are the result of measurement bias. Research needs to be undertaken on the use of adiposity criteria and risk of disease in children using metabolic markers of cardiovascular risk in addition to body composition markers (Viner *et al.*, 2010). In order to address ethnic disparities in childhood obesity, additional research on ethnic variation in child and family health behaviours, norms, beliefs, and perceptions needs to be conducted.

3.6.6.1 Future work

A number of analyses are planned in addition to the analyses conducted for the purpose of this thesis. This includes:

- Adding height z-score to multilevel models for the binary outcome ov/ob or not ov/ob, to partly account for multi-colinearity between BMI and height
- Calculating and conducting analyses using Ponderal Index (kg/m^3) and Benn Index (weight/height^p where the power function p is

derived specifically for each population group) in addition to BMI to explore the role/bias of height upon ethnic group differences in adiposity

- Reassignment of weight status and reanalysis of odds ratios (using UK90 population monitoring cut-offs of >85th centile for overweight) based on Adj zBMI values, to understand how Adj zBMI influences ethnic group differences in odds of ov/ob
- Running the zBMI analyses using the IOTF reference data to see if observed ethnic group differences are due to the use of a different reference population, or use of different diagnostic criteria (centile vs adult cut-offs approach).
- Calculating the proportion of children classified as ov/ob by UK90 definitions who were subsequently classified as not ov/ob by IOTF definitions (or vice versa)
- Applying clinical cut-offs to the current data set to observe the consistency of ethnic group differences and to compare IOTF values

3.7 Conclusions

Through analyses of a local routine surveillance data set, this research has identified ethnic disparities in childhood adiposity in Coventry, which differ by age and sex. In particular, Black African children and girls from other Black ethnic groups may be at increased risk for adiposity from early childhood, whilst the primary school years represent a key time point for intervening to prevent the development of adiposity for boys from South Asian ethnic groups. These findings have implications for the targeting and design of local resources and services in Coventry.

The analyses were able to partly account for the complex ecological context in which childhood obesity arises through use of a cross-classified multilevel model which introduced variables at the individual, school and neighbourhood level, making use of additional data available through the Local Authority. Ethnic disparities in child adiposity were generally not explained by these individual, school and neighbourhood characteristics. School and neighbourhood contexts appeared to account for very little of the variation observed in childhood zBMI in Coventry, and future research should take into account additional ecological contexts such as the family.

Although ethnic group disparities remained consistent when using alternative reference charts and ov/ob cut-offs (IOTF), ethnic group patterns changed substantially when zBMI was adjusted for height and the fat mass values provided by Hudda *et al.* (2017a). These findings highlight the potential misgivings in using BMI to investigate ethnic group variation in overweight and obesity and a priority for future research is to assess the validity of fat mass-adjusted values for BMI. This is important in order to prevent the inappropriate targeting of Black ethnic groups for obesity prevention services and to ensure timely intervention for children from South Asian groups if necessary.

Strengths of the study include utilisation of local data and a large data set, allowing exploration across a broad range of ethnic groups. However, as a secondary analysis, the variables were limited by the available data. There is a need for further exploration of the factors driving ethnic group disparities in overweight and obesity, in particular the influence of cultural and contextual factors using qualitative methods.

3.8 Chapter summary

This secondary analysis of NCMP data helps to address the lack of existing evidence to understand the basis of ethnic group inequalities in childhood adiposity, identified in the previous chapter, particularly through identifying age and sex-specific patterns in ethnic variation in child adiposity and further exploring the interaction between ethnicity and deprivation. The study also explored the contextual basis of childhood adiposity through accounting for variation at multiple levels of influence, using multilevel modelling. Although the analyses included examination of the influence of metrics of adiposity, the conclusions that can be drawn from this are uncertain due to limitations in the data and analysis, although some directions for future research were identified.

The findings inform the next stages of the research through identifying ethnic groups at high risk for childhood overweight and obesity in Coventry, in particular, older children (end of primary school) from Bangladeshi, Pakistani and Black ethnic groups. The findings also highlight potential individual and contextual factors for further qualitative exploration in the next stages of the research, including the potential role of ethnic variation in child and family health behaviours, norms, beliefs, and perceptions.

Chapter 4 Children's perspectives and experiences of health, diet, physical activity and weight

4.1 Chapter outline

This chapter reports on the conduct and findings of a primary qualitative research study with children in Coventry, aimed at better understanding the cultural and contextual influences over children's diet, physical activity and weight management behaviours from their own perspectives, a recommendation arising out of a systematic review of the literature (study component 1) reported in Chapter 2. This research is intended to complement study component 4 (qualitative research with parents). In addition, the findings are explored in further depth in a mixed methods analytical integration of all study components in Chapter 6.

4.2 Background

Although there is a substantial body of evidence exploring the determinants of childhood obesity through observational and experimental research (Cappuccio *et al.*, 2008; Costigan *et al.*, 2013; Malik *et al.*, 2013; Ruan *et al.*, 2015; Silventoinen *et al.*, 2009; Szajewska & Ruszczynski, 2010; Valdes *et al.*, 2013; Weng *et al.*, 2012; Williams *et al.*, 2014), such studies can overlook the experiential, contextual and cultural basis of such behaviours and their relationships to obesity. Such research topics lend themselves well to qualitative investigation.

In terms of a mechanism by which ethnicity may influence a child's risk of overweight and obesity, ethnicity incorporates aspects such as SES, migration status, experiences in society, cultural practices and norms, and lifestyle and genetic influences (Mathur *et al.*, 2013), potentially resulting in individual, cultural and contextual differences through which ethnic inequalities in obesity may develop.

4.2.1 The perspectives of children

The research to date has provided some insight into childhood obesity-related beliefs and behaviours from the perspectives of parents (Pocock *et al.*, 2010; Towns & D'Auria, 2009) and children (Rees *et al.*, 2011). Qualitative approaches have been useful in exploring contextual influences upon food and physical activity behaviours and beliefs related to body weight in UK children from the perspectives of children (Pearce *et al.*, 2009), and recently studies have started to explore the influence of ethnicity upon these perspectives (Eyre *et al.*, 2015b; Rawlins *et al.*, 2013; Trigwell, 2011). These studies found a range of common perspectives, but also highlighted some perspectives related to children's social and ethnic backgrounds.

However, a systematic review of the literature on the perspectives of primary school aged children in the UK in relation to weight found that many qualitative studies were of low-to-middle quality, in particular lacking methodological features that aimed to privilege children's own framing of issues around obesity, and lacking rigour in sampling, data collection or analysis (Rees *et al.*, 2011). Included studies gave little consideration to the role of SEP and ethnicity in sampling and analysis, with a slight overall bias in sampling towards children from high socioeconomic groups. In addition, studies did not present their findings in great depth or breadth, and no studies directly asked children what they thought should be done to help them to reach or maintain a healthy weight.

The moral and philosophical importance of eliciting children's experiences in relation to their own health has been viewed as key, from a research, policy and service-design perspective (Children and Young People's Unit, 2001; Davey, 2010; National Children's Bureau, 2015; United Nations, 1989). Within the context of research, the last few decades have seen a move away from researching children as passive participants within an adult world, and towards acknowledging them as active individuals with their own agency, perspectives and experiences (Hill *et al.*, 1996). The power imbalance that arises out of the child participant – adult researcher relationship can result in the child providing the 'expected' or 'right' answer, as they perceive it (Hill *et al.*, 1996). Child-centered approaches help to address the imbalance by having the researcher step into the child's world (Horstman *et al.*, 2008).

The purpose of including a sample of children in this research is to better understand their day-to-day experiences of life recounted in their own words, which may differ greatly from adults' perspectives of the child's experiences. In the case of diet and physical activity, some of a child's experience occurs independently of adults e.g. in the school cafeteria or playground, or jointly e.g. at the family dinner table. As such, a child-centred approach is warranted within this research to allow the research to be conducted 'with' children rather 'on' them and explore their experiences from their own perspectives.

Qualitative approaches provide a means of accessing children's views and perspectives, expressed in their own terms, and can help to address some of the traditional power imbalances present in research with children (e.g. reducing the dominant role of the researcher), reducing the potential influence of adult-led agendas.

4.3 Study aims

The aim of the current study was to identify the cultural and contextual factors that influence childhood overweight and obesity in Coventry through an exploration of child perspectives and experiences around diet, physical activity and weight. The objectives were to understand:

- The knowledge, understandings, beliefs and motivations of children around the concepts of health, diet, physical activity and childhood weight
- Child reports of the dietary, physical activity and weight management behaviours within their families and the factors that influence these behaviours
- Children's perceived barriers and facilitators to achieving a healthy weight
- Similarities and diversity in children's perspectives and experiences in relation to ethnicity

The study also aimed to address the lack of qualitative research exploring the views of those from deprived backgrounds, to ensure the study was of relevance to Coventry as an area with a deprived childhood population.

In addition, the study aimed to make use of a child-centred research methodology (a 'draw, write and tell' technique) that sought to rigorously elicit children's perspectives of these issues recounted in their own words.

4.4 Methods

4.4.1 Sampling and recruitment

Primary school aged children were the focus of this research given the large increases observed in overweight and obesity prevalence from reception year to year 6, especially in minority ethnic groups (Health and Social Care Information Centre, 2014b). On this basis, children from year 5 (aged 9-10 years) were recruited through primary schools in Coventry, aiming for a sample size of 20 children from across at least two different schools and consisting of a broad range of ethnicities. Children at this age can typically begin to comprehend more abstract concepts (Backett & Alexander, 1991) and were viewed as more appropriate to recruit than year 6 children, who have a busy academic year as they begin to transition into secondary school.

The sampling frame was designed to consider the following child factors:

- Ethnicity
- Socioeconomic status
- Weight status

4.4.1.1 Sampling of schools

In the first instance, schools were sampled, using the following approach:

- A high total proportion of children from Black and Minority ethnic (BME) groups (>Coventry average); and/or:
- A high proportion of any of the following ethnic groups: White other, Indian, Pakistani, Bangladeshi, Black African and Black Caribbean (>Coventry average); and/or:
- A high proportion of children having free school meals (>Coventry average); and/or
- Expressed an interest in the study in opportunistic interactions with the researcher or other gatekeepers e.g. following visits to Head Teacher forum etc.

Ethnicity and free school meal data were accessed via the school census. The sampling frame was designed to achieve an ethnically diverse sample, with high proportions of the largest minority ethnic groups in Coventry. Free school meals data were intended to reflect schools with a high proportion of children from lower socioeconomic backgrounds. Of the 85 state primary schools in the city open to pupils in the academic year 2015/16, 16 schools were invited to take part.

4.4.1.2 Sampling of children

In schools with a high response rate, additional sampling was applied at the child level by prioritising children from BME groups. Once children from these groups had been interviewed, children were interviewed sequentially in order of response forms received.

In order to achieve a sample with children from overweight and obese categories represented, additional recruitment of children was attempted through school-based (after-school) programme 'One Body One Life' (OBOL), a healthy weight service delivered by Coventry City Council, which actively recruits overweight children in addition to healthy weight children. OBOL sessions on two different sites were visited, with recruitment packs distributed.

4.4.1.3 Recruitment methods and consent procedure

School leaders from the selected schools were contacted and invited to take part. In participating schools, class visits were undertaken prior to recruitment where possible to explain the research in child-friendly terms. This aimed to put children at ease and build familiarity with the potential participants. Child-friendly participant information sheets (Appendix 16) were distributed to all children in year 5 classes, along with parent information packs to take home comprising of a parent information sheet (Appendix 17), a screening questionnaire (Appendix 18) and a consent form (Appendix 19), with return envelopes addressed to the teacher.

Interview days were arranged with the school for those children with parental consent. An additional explanation of the study was provided verbally to the child prior to the interview. Children were provided with some options and phrases for ceasing the interview if they chose (although no children chose this option), and the digital recorder was demonstrated to the child, with the participant being invited to start and stop the interview by pressing the appropriate buttons. The interviewer then checked participant understanding using two questions, adapted from Hensel *et al.* (2002): "*what will I be talking to you about today?*" and "*what should you do if you don't want to talk to me anymore?".* Children were given the opportunity to ask questions then asked for verbal consent. If a child was non-participative, the interviewer checked if they were happy to continue, and if so, offered alternative activities or question types in an attempt to encourage engagement.

Parental information packs and topic guides were reviewed by a Patient and Public Involvement representative for the NIHR, and the data collection methods were piloted with four children from a school in Birmingham, and adapted according to children's feedback and researcher reflections.

4.4.2 Data collection

Semi-structured one-to-one interviews were used because of the potential for sensitive topics to arise, and were conducted in a quiet and relatively private space (e.g. meeting room, community room) within the school during the school day or at breakfast club. Data collection methods and tools were designed to aid and empower children's communication of their thoughts, and to minimise the potentially dominant role of the researcher in the child-researcher relationship. In addition to the methods described below, this included being seated at the same level as the child, avoidance of appearing judgemental, use of rephrasing when appropriate (as opposed to repeating the question), and checking children's definitions of words or phrases (Greene & Hogan, 2005).

Although translation services were not formally available for children with English as a second language, in the case of one participant, another classmate was invited to support the child with any language difficulties encountered during the interview. In this case, the classmate had frequent prior experience of supporting the child with translation in the classroom setting and permission was requested from both the participant and the classmate independently to ensure both were comfortable with the arrangement.

4.4.2.1 Data collection tools

Demographic data were collected to support sampling and analysis. Parents completed a screening questionnaire (Appendix 18) to collect child postcode and child ethnicity (using census categories). An interview-administered questionnaire with children collected child age and a measure of family affluence using the family affluence scale II (FAS II) and ethnic background using the Ethnic Background Indicators tool from the Health Behaviours in Schools-aged Children study (HBSC-EBI) (Appendix 20), both of which are validated for use in 11 year old children (Andersen *et al.*, 2008; Nordahl *et al.*, 2011).

4.4.2.1.1 The draw, write and tell technique

A 'draw, write and tell technique' was selected as an engaging, participatory, familiar and non-threatening method of data collection that provided a structured way for children to gently recall experiences, construct cognitively complex ideas, enhance communication between researcher and child and support meaning-making (Angell *et al.*, 2014).

In this study, children were first asked to draw a picture of a healthy child, and then an unhealthy child. These images were then used as a launch pad for discussing children's views on health, diet, physical activity and weight. The opening question *"can you tell me about your picture?"* was intended as a way to enable child-led dialogue, before moving on to questions outlined in a semi-structured topic guide (Appendix 21). This topic guide consisted of a mixture of direct and indirect questions, developed using socioecological models (SEM) of childhood obesity as a theoretical framework, as detailed in Chapter 1 (Harrison *et al.*, 2011b). This ensured that questions and prompts were included that aimed to explore the potential multiple levels of influence upon children's behaviours, in particular, the child, the family, the school and the neighbourhood.

Initial instructions and questions were intentionally broad to understand children's interpretations of the term 'health' before moving on to more directive sub-questions regarding perspectives and experiences on diet, physical activity and body size, including barriers and facilitators to health behaviours at multiple levels of influence. Children were also advised that they could write on the paper, and that they did not have to draw a picture if they did not wish to.

Drawn images, written text and discourse were captured as data (examples of which are provided in the results). Field notes were taken to note emerging themes and challenges arising, with future interviews adapted in an inductive style to reflect these considerations. A reflective journal was maintained to regularly reflect on my personal perspectives and values relating to the research concepts.

4.4.3 Data preparation and analysis

Interviews were recorded on an audio digital recorder and transcribed verbatim through an external transcription service and reviewed for accuracy and to develop familiarity. Each participant was allocated an individual ID number post- interview, which was then matched to their transcript, drawn images and participant characteristics.

Framework analysis was conducted based on the process detailed by Gale *et al.* (2013) and is summarized in Figure 4.1.

4.4.3.1 Coding

Free coding was used to note preliminary thoughts on the underlying meaning in transcripts. These were then reviewed and refined as more transcripts were coded, adding new codes as necessary until no new codes arose. Codes were then grouped into categories and sub-categories. Throughout coding and categorising, the SEM was informally used to conceptually guide the process, for example, barriers and facilitators to health behaviours were organised into separate codes based on the level of influence (i.e. friends, family, school, open space and wider influences); and the category 'responsibility for health' included codes for personal responsibility, external influences and societal/collective responsibility. This was done inductively and informally (i.e. codes were not matched directly to the SEM at this stage). Meetings were held with supervisors (WR, RJ and FB) to discuss codes and finalise the coding framework. Once a coding framework was finalised, transcripts were imported into NVivo v11 alongside typed field notes and reflective notes, and the full set of transcripts were systematically coded (or re-coded if necessary) using the approved framework.

4.4.3.2 Charting and emerging themes

Data were then abstracted and charted into a case-code matrix, which was used to understand 'emerging themes', identify divergent beliefs and views, and seek both common themes across all groups and those unique to specific ethnic groups. Drawn images and written text were also concurrently coded by describing the pictures and noting recurring ideas, and these were added to the case-code matrix (as descriptions of the images/text). Analytical memos were constructed to develop the emerging themes, grouping codes that formed specific patterns and linking codes and participant characteristics. These analytical memos also included a column linking codes and emerging themes more formally to the levels of influence outlined in the SEM, to help conceptualise the levels of influence that appeared to be most influential for children. Some retrospective coding of drawn images and written text was undertaken to explore the emerging themes further through the drawings and text, with counts sometimes used to identify the number of children that made reference to an emerging theme in their images/text.

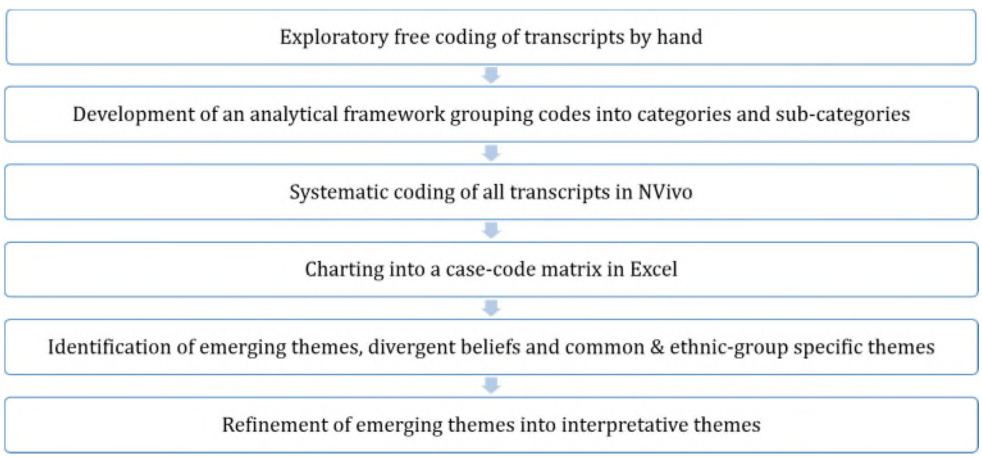
4.4.3.3 Interpretative themes

Finally, these emerging themes were studied and refined into final 'interpretative themes' that went beyond descriptive analysis by seeking possible explanations for what was happening within the data. These interpretative themes were also discussed with supervisors.

The case code matrix was also further organised by ethnic groupings to explore any diversity in perspectives, initially using the aggregated groupings White British, White other, Black African or Caribbean, South Asian, and other ethnic groups, before assessing any within-group on the basis of disaggregated ethnic groupings and child and parental place of birth. Again, some retrospective coding and counts of drawn images and written text was undertaken to explore any emerging themes (i.e. diversity in perspectives) in more detail.

Comparisons between drawn images/written text and children's transcripts were also explored.

Figure 4.1 Analytical process diagram



To support the presentation of data, each case was assigned a series of labels as follows: participant number (ID), boy/girl, ethnicity, child's migration status (UK born or born abroad) and parental migration status (both UK born, or either/both born abroad). Verbatim quotes and drawn images with participant labels are provided to support the findings.

4.5 Results

4.5.1 Sample description

Eleven of the sixteen schools responded to the invitation and six schools agreed to participate, with children successfully recruited from three schools. In addition, 15 children from two OBOL programmes were invited. Although four packs were returned, these families declined to take part upon follow-up. Demographic characteristics relating to the proportion of children from BME groups and taking free school meals (FSM) and recruitment numbers for these schools are summarised in Table 4.1

Table 4.1 Characteristics of participating schools

School ID	BME pupils (%)	FSM (%)	Packs distributed (n)	Interviews completed (n)
1	66	43	60	9
2	90	31	60	5
3	86	31	90	12

Participant characteristics are provided in Table 4.2. Ethnicity is provided based on census categories. Where the parents of participants selected 'other', they were asked to specify their child's ethnic group in a free text box, and this self-description is detailed where provided Table 4.2.

Table 4.2 Participant characteristics

ID	Ethnicity	Boy/girl	Age	Deprivation decile (10 = highest decile)	Child migration status	Parental migration status	School
ID1	Black African	Girl	10	10	UK born	Both UK-born	School 1
ID2	White European	Girl	9	10	UK born	Both parents non-UK born	School 1
ID3	Black African	Girl	10	10	Non-UK born	Both parents non-UK born	School 1
ID4	White European	Boy	10	10	Non-UK born	Both parents non-UK born	School 1
ID5	White British	Boy	10	Not stated	UK born	Both UK-born	School 1
ID6	Other: British Pakistani	Girl	10	10	UK born	One parent UK born	School 2
ID7	Asian Indian	Boy	10	9	UK born	Both parents non-UK born	School 2
ID8	Arab	Boy	10	10	UK born	Both parents non-UK born	School 2
ID9	White British	Girl	10	10	UK born	Both UK-born	School 1
ID10	Black African	Girl	10	10	UK born	Both parents non-UK born	School 1
ID11	White European	Boy	10	10	Non-UK born	One parent UK born	School 1
ID12	Other: Afghan	Girl	10	8	Non-UK born	No response	School 1
ID13	Asian Indian	Girl	9	10	UK born	One parent UK born	School 2
ID14	Black African	Boy	10	8	UK born	Both parents non-UK born	School 2
ID15	Asian Bangladeshi	Girl	10	10	UK born	Both parents non-UK born	School 3
ID16	Other: Black African and Arab	Boy	10	10	UK born	Both parents non-UK born	School 3
ID17	Arab	Boy	10	8	UK born	One parent UK born	School 3
ID18	White British	Girl	10	9	UK born	Both UK-born	School 3
ID19	Other: Afghan	Girl	10	9	Non-UK born	Both parents non-UK born	School 3
ID20	Asian Bangladeshi	Girl	10	10	UK born	Both parents non-UK born	School 3
ID21	Other: Kurdish	Girl	10	10	UK born	Both parents non-UK born	School 3
ID22	White British	Girl	10	10	UK born	Both UK-born	School 3
ID23	Asian Indian	Boy	10	8	UK born	One parent UK born	School 3
ID24	Other: White British and Asian Indian	Girl	10	10	UK born	One parent UK born	School 3
ID25	White British	Girl	10	10	UK born	Both UK-born	School 3
ID26	Other: Iranian	Boy	10	10	Non-UK born	Both parents non-UK born	School 3
ID27	Asian Bangladeshi	Boy	10	10	UK born	Both parents non-UK born	School 3

Table 4.3 summarises the demographic characteristics of the 26 children with completed interviews. An ethnically diverse sample was achieved with 85% (n = 22) of children from non-White British backgrounds, with 31% (n = 8) having a South Asian background (including one child of mixed White British and Indian ethnicity); 15% (n = 4) having a Black African background; 12% (n = 3) from White other backgrounds; and the remainder (27%; n = 7) from other backgrounds consisting of Arab, Iranian, Kurdish or Afghan backgrounds (including one child from a mixed Black African and Arab background). All children interviewed lived in Lower Super Output Areas (LSOAs) of high deprivation, the majority of which (69%; n = 18) were in the top quintile for IMD in the UK. However, most children did not report material disadvantage according to the FAS II, with most achieving middle to high scores. Most children interviewed were UK-born (76.9%; n = 20) but had at least one parent born outside of the UK (77%; n = 20). A higher proportion of girls were interviewed (58%; n = 15).

Table 4.3 Sample description

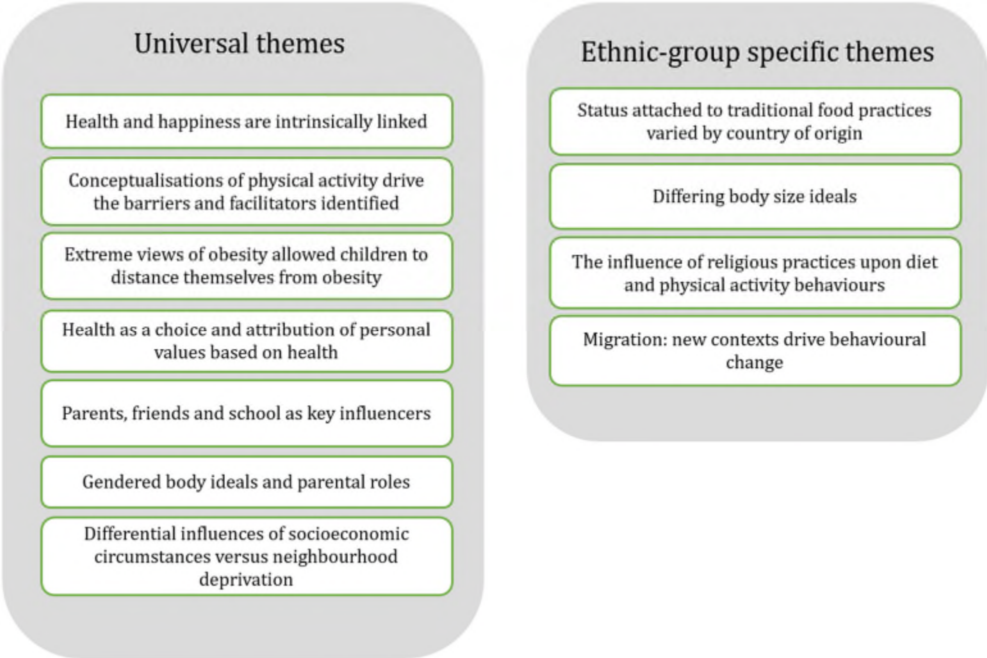
	Girls	Boys	Total
Ethnic group (census category)			
White British	3	1	4
White other	1	2	3
Mixed ethnicity	0	0	0
Asian Indian	1	2	3
Asian Pakistani	0	0	0
Asian Bangladeshi	2	1	3
Any other Asian	0	0	0
Black African	3	1	4
Black Caribbean	0	0	0
Black other	0	0	0
Chinese	0	0	0
Any other ethnic group[1]	5	4	9
Not stated	0	0	0
IMD quintile of home postcode			
5 Most deprived	12	6	18
4	2	1	3
3	1	3	4
2	0	0	0
1 Least deprived	0	0	0
Not stated	0	1	1
Family affluence (FASII)			
Low	4	2	6
Medium	6	5	11
High	5	4	9
Country of birth			
UK	12	8	20
Non-UK	3	3	6
Parental country of birth			
2 parents born abroad	7	7	14
1 parent born abroad	3	3	6
Parents both UK-born	4	1	5
Not stated	1	0	1
Total	**15**	**11**	**26**

[1] Including those selecting the following groups or self-defining their child's ethnic group: Arab (n=2); Afghan (n=2); British Pakistani (n=1); Kurdish (n=1); Iranian (n=1); Mixed Black African & Arab (n=1) and Mixed White British and Indian (n=1).

4.5.2 Interpretative themes

Eleven themes were identified (Figure 4.2) and are discussed in detail below, with supporting quotes and drawn images/text from children provided. The vast majority of themes were widely applicable across the sample, yet a small number of specific themes arose relating to children's ethnicity (e.g. culture, traditions, religion, migration) and gender, both explicitly referenced by children and following sub-group comparisons. Few themes arose relating explicitly to children's socioeconomic circumstances e.g. income, environmental deprivation; however this study did not aim to take a comparative approach on the basis of SEP. The majority of children linked health to weight status, identifying the unhealthy child as 'overweight', therefore references to 'the unhealthy child' are also viewed as related to overweight status.

Figure 4.2 Interpretative themes identified in child interviews



4.5.2.1 Universal themes

A summary of universal themes with example quotes is provided in Table 4.4.

Table 4.4 Universal themes and example quotes

Themes	Example quotes
Health and happiness are intrinsically linked	• "I think they [the healthy child] would be happy and bubbly because they're healthy" *ID14, Boy, Black African, UK born, 2 parents born abroad* • "vegetables and fruit have got loads of like good ingredients that when you eat it like, it makes you feel good about yourself" *ID9, Girl, White British, UK born, 2 parents UK born* • "…when you don't exercise the happy chemicals don't get released so you won't be a really happy person" *ID6, Girl, British Pakistani, UK born, 1 parent born abroad* • "if you're sad it's really hard to get fit… Because you're not in the mood to do anything because you're so angry and frustrated at everyone else, you're like no I'm never going to do it." *ID3, Girl, Black African, Non-UK born, 2 parents born abroad*
Conceptualisations of physical activity drive the barriers and facilitators identified	• "…park is exercise, because you're running around and that." *ID9, Girl, White British UK born, 2 parents UK born* • "He [the unhealthy child] likes to sleep for the whole day and sometimes he watches TV a lot and when his mum tells him to go outside to run around, he just sleeps again. And he doesn't like going outside, he likes staying inside." *ID15, Girl, Bangladeshi, UK born, 2 parents born abroad* • "I have like friends near me so there's a park down the corner and we run around and play and that." *ID9, Girl, White British, UK born, 2 parents UK born* • Interviewer: "Why do you think those things make him unhealthy?" ID5: "Because if he doesn't go outside and just stays in it's not going to help him get better at stuff, and not fit, so you need to go outside." *ID5, Girl, White British, 2 parents UK born* • "…last week, we friends go out and play football…. And I see someone shouting and I go check it and I see, you know, six mans [men], fighting, and one or two mans [men] stop them. That's why, you know, I [I'm] not playing football." *ID26, Girl, Other ethnicity (Iranian), Non-UK born, 2 parents born abroad* • "When it's raining, I will just sit down and watch TV. When it's shiny [sunny] I will go outside, ride my bike, calling friends outside to play." *ID4, Boy, White other, Non-UK born, 2 parents born abroad*
Extreme views of obesity allowed children to distance themselves from obesity	• "…like some other children are like whispering to each other saying about how fat he [the unhealthy child] is, how big a chair he needs. Like because he's like that fat he has to have this very large one..." *ID5, Boy, White British, UK born, 2 parents UK born* • "He don't like nothing because he's too big, he can't sit nowhere, he has to sit on the floor. He's bored, coz got no friends… he can't get anywhere because he's too fat, so he has to go in his taxi car and things" *ID1, Girl, Black African, UK born, 2 parents UK born* • "I'm not the healthiest, but I'm not the fattest as well. I'm kind of over the middle because I'm okay for me weight" *ID7, Boy, Indian, UK born, 2 parents born abroad* • "… if you're fat you get bullied really easily." *ID3, Girl, Black African, Non-UK born, 2 parents born abroad* • "The more he eats he's probably going to get obese or corpulent… He probably won't be able to walk. And like always have to stay at home." *ID14, Boy, Black African ethnicity, UK born, 2 parents born abroad* • "It's hard for a fat child to get healthy because they're scared that everyone will be like, ha, ha, ha, look he's so fat and your belly jiggles and your legs jiggle, and you might feel really ashamed of your body and then it's really hard."

Themes	Example quotes
	ID3, Girl, Black African, Non-UK born, 2 parents born abroad
Health as a choice and attribution of personal values based on health	• "He [the unhealthy child] wishes he was fit but obviously he can't be bothered to. That's it." *ID5, Boy, White British, UK born, 2 parents UK born* • "...you have to sometimes think that you like something but you've got to make the right choice and pick something that's a bit healthier." *ID11, Boy, White other, Non-UK born, 1 parent born abroad* • "Nothing stops me [being healthy], other than myself, but nothing really stops me" *ID10, Girl, Black African, UK born, 2 parents born abroad* • "I used to eat crisps a lot, now I've stopped eating crisps a lot… Because I thought this was getting bad for my health and the future's not going to be good for me" *ID7, Boy, Indian, UK born, 2 parents born abroad* • "Making sure that when we go shopping my mum and dad do pick up some healthy foods." *ID22, Girl, White British, UK born, 2 parents UK born* • "I made like this spreadsheet and I put in all my data, like what I've had healthy and at what time, and what day. And then I make like a report out of it… And he [my dad]… he gives me a reward if I've done something, like if I've improved" *ID23, Boy, Indian, UK born, 1 parent born abroad* • "[The healthy child is] Very funny, he's very determined and very resilient." *ID7, Boy, Indian, UK born, 2 parents born abroad* • "… when you're not very healthy you're like not very kind and when you're really healthy you're very kind.." *ID18, Girl, White British, UK born, 2 parents UK born* • "…the boys would probably think he's too lazy to play, we're not going to try encouraging him, I don't want him on our team if he does want to play. And he'll be too lazy to go on any of the teams. He'll probably rather sit inside and do something in there, instead of play football with us, which is lucky." *ID13, Girl, Indian, UK born, 1 parent born abroad*
Parents, friends and school as key influencers	• "When my mum tells me what... I ask her, what do we eat, and then she tells me… She tells me what benefits it has inside, and how much calories, and how good it is." *ID16, Boy, Mixed ethnicity (Black African and Arab), UK born, 2 parents born abroad* • "…sometimes I eat too much sweets, and then I get told off" *ID1, Girl, Black African, UK born, 2 parents UK born* • "My mum helps me by cooking healthy meals" *ID18, Girl, White British, UK born, 2 parents UK born* • "She [my friend] was the one who helped me because I told to her to like put a bit more weight on but she told me to lose a lot of weight and I've done it. So that's a goal that I wanted to do and I've achieved it." *ID9, Girl, White British, UK born, 2 parents UK born* • "…in school we do Food Dudes, and we have to try and eat as many fruit and vegetables and we can and then they sign it off and then you get presents when you finish one card." *ID6, Girl, British Pakistani , UK born, 1 parent born abroad* • "…all of my teachers and that, because they're always like, 'oh what did you eat for dinner' and that sort of thing. And I'm just like, 'oh I had this and this and this', and they'll be like, 'wow, that's so healthy'" *ID24, Girl, Mixed ethnicity (White British and Asian Indian), UK born, 1 parent born abroad* • "They [the school] might be healthy by… by eating more healthy food instead of junk food, and then they would be happy and then they might inspire the other person. And then the other person might inspire others, and then it goes on and on." *ID16, Boy, Mixed Ethnicity (Black African and Arab), UK born, 2 parents born abroad*

Themes	Example quotes
	• "Well, they [the school] don't just like say, 'oh this person needs to this to be healthy', they give the same information to everybody, so not just them, because then that's just like a bit mean like you're like picking on somebody… So I think they tell the same information to everybody which benefits us all." *ID24, Girl, Mixed ethnicity (White British and Asian Indian), UK born, 1 parent born abroad*
Gendered body ideals and parental roles	• "In this world people, all the adults and other countries, all the countries, you're skinny, you're beautiful, you're going to make a lot of money... They say that beautiful is all you have to be to get... to be, well, amazing." *ID3, Girl, Black African, Non-UK born, 2 parents born abroad* • "…this girl is underweight and she doesn't like eating because like she's scared to gain weight because she doesn't want to be fat when really she's not even the average weight." *ID20, Girl, Bangladeshi, UK born, 2 parents born abroad* • "…she's very strong and other people don't have very strong bodies. And some people have very strong bodies because they do like exercise and eat healthy foods and do lots of things." *ID18, Girl, White British, UK born, 2 parents UK born* • "I think my mum does [help me to be healthy] because she has a treadmill upstairs and she does about around about half an hour to an hour on it every day. And then I think that actually it looks quite fun and then I think I should ride my bike more often..." *ID6, Girl, British Pakistani, , UK born, 1 parent born abroad*
Differential influences of socioeconomic circumstances versus neighbourhood deprivation	• "…where I live… there's not lots of cars because it's not a main road. So I just go running there, or I go biking." *ID17, Boy, Other ethnicity (Arab), UK born, 1 parent born abroad,(IMD decile 8)* • "I have to walk everywhere… Because only my brother can drive, but he like can't drive anyone anywhere; he does it for work." *ID18, Girl, White British, UK born, 2 parents UK born, (IMD decile 9)* • "Having a bike and living in a flat [helps me to be healthy], because it means you have a big area which means... and it's always empty so you can always ride play." *ID21, Girl, Other ethnicity (Kurdish), UK born, 2 parents born abroad, (IMD decile 10)* • "There isn't any leisure centres for him [the unhealthy child]. There isn't any parks, nothing. He's all... it's very messy as well and there's nothing there." *ID7, Boy, Indian, UK born, 2 parents born abroad, (IMD decile 8)* • "[We] have chicken and chips sometimes because near to where we live." *ID21, Girl, Other ethnicity (Kurdish), UK born, 2 parents born abroad, (IMD decile 10)* • ID14: "Some people, when we go to the park, which is like a 2 minute walk, some people in the park they write swear words" Interviewer: "Do they?" ID14: "Yeah. On the climbing frame, on the swings" Interviewer: "And do you think that affects your health?" ID14: "Hmm. Not that much, I just try to forget about it and play with my brothers" *ID14, Boy, Black African, UK born, 2 parents born abroad, (IMD decile 8)*

4.5.2.1.1 Health and happiness are intrinsically linked

For children, health and happiness were viewed as intrinsically linked i.e. being healthy makes you happy; and being happy makes you healthy. The converse was also that unhealthy or overweight children were viewed as unhappy e.g.*"they're really sad because they're fat"*.

Children generally defined 'health' as mental and social well-being that allows active participation in life. Children felt that happiness came as a result of a chemical response from physical activity and eating healthy foods, being physically active with friends, and the absence of illness. Happiness was seen to drive health behaviours by providing a sense of positivity and enthusiasm which made health behaviours easier.

Unhealthy children were viewed as sad because they are worried, ill, bored, have few friends and are not able to fully engage in day-to-day life, including play and learning. Children felt that being unhealthy or overweight caused anger, tiredness and slowness. There was some deviation from this commonly held view, with unhealthy children sometimes described as happy because of the short-term gratification achieved from unhealthy behaviours e.g. eating sweets. Some supported the view that being occasionally unhealthy is 'good for the mind'.

Sub-group analysis also revealed that a 'healthy mind' may be a particular motivator to keeping healthy for children from South Asian or Black African groups, with these children incorporating both academic achievement and mental well-being into their conceptions of a healthy child.

This theme is further exemplified in one child's drawing of a 'healthy child' (Figure 4.3). When describing his picture, this boy said:

> "This child has a smiley face. Has a smiley face because he has good health and like he's not a major risk and he's also like active because he has like enough nap time. And then he's very… he's

eating very healthy food which makes him healthy and he's not a bad risk. Also he's wearing a t-shirt which says, 'keep calm and stay happy' because it encourages him to be happy."

ID8, Boy, Other ethnicity (Arab), UK Born, 2 parents born abroad

Figure 4.3 Child drawing: Health and happiness are intrinsically linked
ID8, Boy, Other ethnicity (Arab), UK Born, 2 parents born abroad

4.5.2.1.2 Conceptualisations of physical activity drive the barriers and facilitators identified

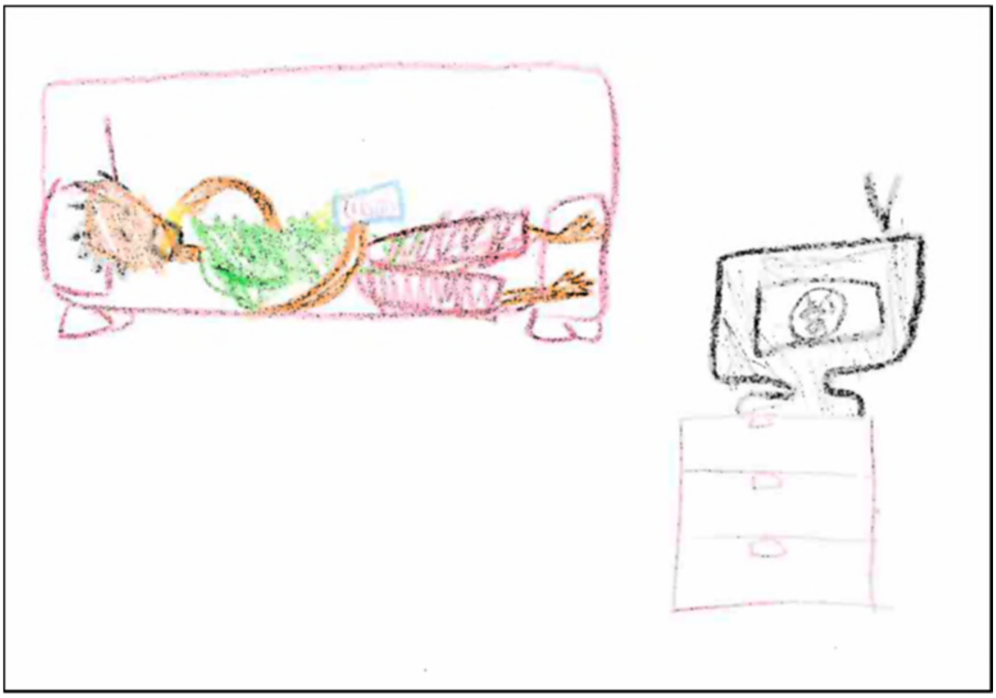
Children conceptualised physical activity as outdoor play, and did not view the home as a space for physical activity. Being outdoors was viewed as essential for achieving high levels of physical activity. Conversely, sedentary activities were linked to indoor time (especially the home) and use of technology, and there was a view that unhealthy children have a preference for being indoors. This is demonstrated in one child's drawing of a healthy child and an unhealthy child. The 'healthy child’ is seen surrounded by grass with a bicycle (see Figure 4.4), whilst the ‘unhealthy child’ is lying on the sofa watching TV (Figure 4.5).

Figure 4.4 Child drawing: Physical activity as an outdoor pursuit

ID21, Girl, Other ethnicity (Kurdish), UK born, 2 parents born abroad

Figure 4.5 Child drawing: The home as a sedentary space

ID21, Girl, Other ethnicity (Kurdish), UK born, 2 parents born abroad



This conceptualisation of physical activity as outdoor play had some implications for the facilitators and barriers that children identified in relation to physical activity. For example, children valued family and friends for facilitating physical activity through co-participation in outdoor play, particularly in the park. School was also viewed as a space for physical activity as it provided access to friends and opportunities for play.

Children appeared personally restricted in physical activity by bad weather, experiences or concerns around safety in public spaces and a personal desire for some periods of inactivity throughout the week (usually linked to TV-viewing or time spent on the computer). These barriers appeared to relate to the idea that children viewed physical activity as an outdoor pursuit, and in contrast, related the home to sedentary pursuits.

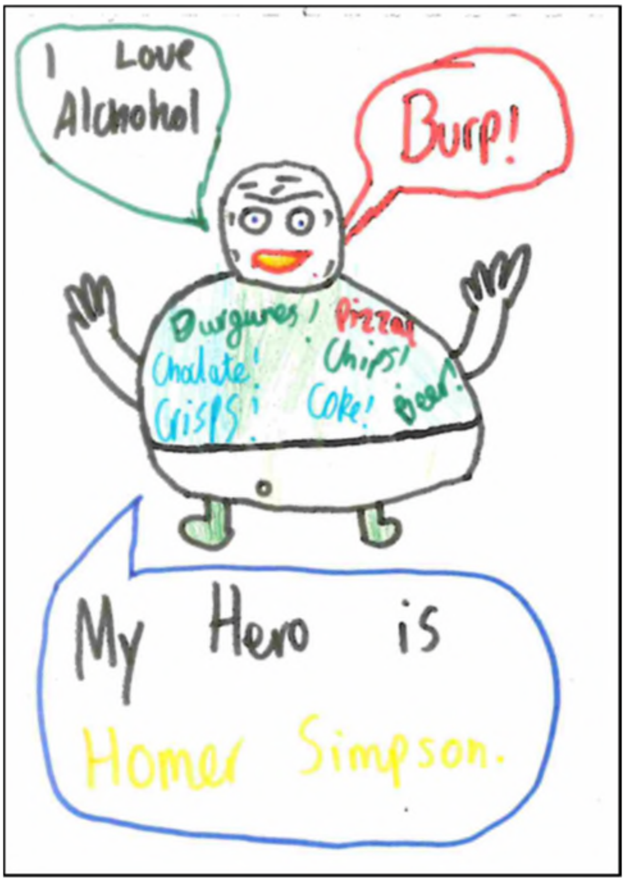
4.5.2.1.3 Extreme views of obesity allowed children to distance themselves from obesity

Children had extreme views of overweight, often viewing it as extreme fatness, bigness or and morbid obesity. Children viewed an overweight body as comically large at times, with some children laughing when describing their picture. This is further demonstrated in one child's drawing of an 'unhealthy child' in Figure 4.6, describing his picture as follows:

> "He's a very fat person and he likes to eat pizza, burgers, chocolate, chips, coke, every day, he loves to have a packet of crisps every day, which doesn't... which isn't bad for him. He's getting... he's oversize and he's really fat. And at school people make fun of him and he... and he thinks his hero is Homer Simpson".
>
> *ID7, Boy, Indian, UK born, 2 parents born abroad*

Figure 4.6 Child drawing: Extreme views of overweight and obesity

ID7, Boy, Indian, UK born, 2 parents born abroad



Being overweight was viewed as restricting mobility and day-to-day abilities and limiting a person's ability to take part in society, including not having many friends.

Children's unrealistic conceptions of obesity may allow children to distance obesity from their own experiences and interactions - as something that is uncommon or unfamiliar. A small number of children stated concerns related to being overweight at some point (n = 4) e.g. had been identified as overweight, or had made weight loss efforts; and one identified themselves as underweight, which was driven by a wish to avoid being overweight. However, children did not personally identify with the extreme levels of obesity they described when talking about their 'unhealthy child'. This distancing was also demonstrated in the ways in which children described obesity in judgemental and harsh ways, for example through phrases such as *"he just gives up very easily"*, *"she's lazy"* and *"he don't really care"*.

On the other hand, children seemed aware of social taboos regarding weight, demonstrated through some children's reluctance to draw a picture of on unhealthy child e.g. *"I feel quite mean just drawing it"* and *"it sounds rude if I say it"*.

4.5.2.1.4 Health as a choice and attribution of personal values based on health

Children felt in charge of their own health, showing interest and enthusiasm on the topic, and apportioning blame to individuals for poor health 'choices'. Children as a whole identified few barriers to being healthy, and felt it was easy to be healthy. This may relate to the ways in which children conceptualised physical activity as fun (play) and health behaviours as largely driven by children's likes and dislikes (and therefore 'inherent' behaviours that require little thought).

Children felt that diet and physical activity behaviours were driven by children's likes, dislikes and choices, and some children reported a preference for unhealthy foods. However, crucially, participants felt that strong personal will power and creativity enables healthy choices (i.e. 'mind over matter'); and that unhealthy choices are a result of a lack of will power or effort, stubbornness or disinterest.

As well as influencing their own behaviours, children also appeared to have an influence over the family's behaviours, encouraging parents to check food labels, making requests for healthy food when parents go shopping, and making menu plans. In this way, children could be considered 'agents of change' within the home.

Healthy children were thought of as having positive, valued characteristics e.g. nice, likeable, kind, clever, determined, hardworking, positive and popular. Participants took the view that healthy children make friends easily and influence or inspire others to be healthy. Some children took this one step further, considering the healthy child as virtuous, for example the healthy child was thought to be a *"better"* person, doing *"the right thing"* and being *"an aspiration to other people".*

On the other hand, unhealthy and overweight children were thought to have negative, less valued characteristics e.g. unkind, uncaring, bad, lazy, sad, angry, stubborn and unpopular. Participants felt that unhealthy children have a negative influence on others and their surroundings. Negative traits were described as inherent to the 'unhealthy child' e.g. personality traits, but also were viewed as the consequence of an unhealthy lifestyle.

This attribution of personality traits based on health and weight was further exemplified in the motivations for being healthy that children described: children's emphasis was on the social consequences of health behaviours and weight, over the physical consequences. This was partly driven by the attributes assigned to health i.e. success, popularity, and physical capability.

It was generally accepted that the unhealthy and overweight child would be stigmatised by others. Few children empathised with the unhealthy child, which may result from the way in which children apportioned responsibility for health, viewing children's unhealthy behaviours as akin to character flaws.

However, some children did empathise with the 'unhealthy child', and felt that weight-based stigmatisation and its consequences were likely to be unhelpful to children in changing health behaviours, reinforcing unhealthy behaviours such as reduced opportunities to play (for physical activity) and encouraging emotional responses e.g. excessive eating. In addition, despite verbalising strong beliefs that health was largely an individual responsibility, this was contradicted by the way in which children appeared influenced (positively and negatively) by social norms, and they ways in which some children viewed unhealthy behaviours as intrinsic.

4.5.2.1.5 Parents, friends and school as key influencers

Parents appeared to have a key role in helping children stay healthy, through monitoring, reprimanding, building routines, organising family activities, encouraging healthy behaviours, preparing healthy food, identifying health concerns, educating children on health and role modelling.

Children identified friends as key facilitators of healthy behaviours. Having friends made it easier to stay healthy as they encourage a healthy diet, act as role models, identify health concerns and provide opportunities for play.

Schools were largely viewed as positive, enabling, healthful environments, with schools and teachers playing a role in providing sporting opportunities, healthy meals, learning (considered important for brain health), health education and health programmes which incentivise healthy behaviours and provide opportunities for tasting new, healthy foods. Such programmes of work related to health were memorable and motivating, and children described longer-term outcomes from these (not just immediate ones). Schools provided a means to accessing friends, providing opportunities for play. Schools were seen as providing a network where children inspire one another. An additional benefit of the school approach described by children was that it was universal, and did not target (*"pick on"*) specific children, reducing opportunities for stigmatisation.

Characteristics of teachers that were helpful were initiating conversations on what children had had to eat; gentle motivation; and a universal approach (not picking on individual children as examples).

4.5.2.1.6 Gendered body ideals and parental roles

Muscles and strength were viewed as indicators of a healthy body (Figure 4.7). It was noted that a slightly higher proportion of boys took this view than girls (n = 5 out of 11 for boys and n = 5 out of 15 for girls). There also appeared to be greater societal pressure on girls to be a lower weight, identified by a small number of girls (n=2).

Children's images of a healthy child and an unhealthy child were compared, and it was noted that girls as a whole drew both boys and girls; whilst boys only drew boys (based on children's use of the terms 'he' or 'she' when describing their picture). In addition, girls tended to draw the healthy child as a girl and the unhealthy child as a boy (n = 10 out of 15 drew a boy as unhealthy; n = 4 out of 15 drew a girl as unhealthy; and n = 1 out of 15 did not refer to a gender). However, children did not explicitly make claims that boys were especially unhealthy compared to girls during conversation.

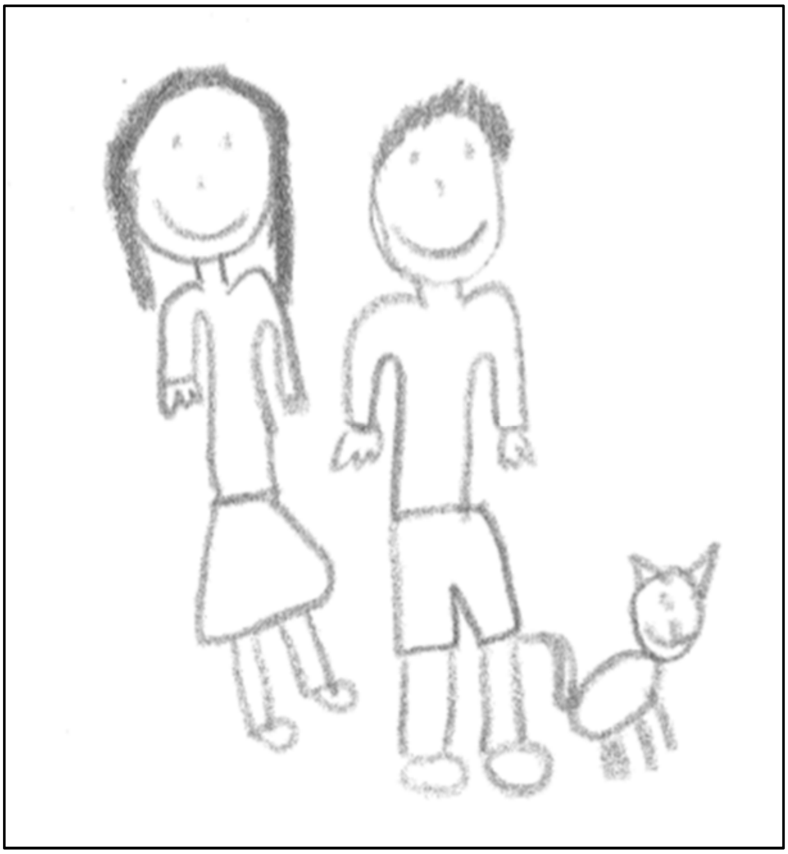
Figure 4.7 Child drawing: A healthy body ideal - Muscles and strength

ID4, Boy, White other, Non-UK born, 2 parents born abroad

Gender also emerged when children considered the role of parents in helping to keep healthy. Mothers were most often cited when referring to preparation of healthy food, although not exclusively, and were viewed as role models. An example is provided in one child's drawing of a healthy child with his mum and his pet cat, (Figure 4.8) and his description: *"Well the mum makes them healthy foods and that, and the cat like it helps them exercise because they play around a lot".*

Figure 4.8 Child drawing: Role of mother

ID27, Boy, Bangladeshi, UK born, 2 parents born abroad



4.5.2.1.7 Differential influences of socioeconomic circumstances versus neighbourhood deprivation

Individual-level socioeconomic circumstances and neighbourhood level deprivation had contrasting influences upon health behaviours. References to the influence of socioeconomic circumstances generally came from occasional mentions of the home environment (e.g. living in a block of flats) and material disadvantage (e.g. not owning a car), which were both seen as enabling physical activity. Some implicit references to neighbourhood deprivation were made (e.g. descriptions of crime and safety concerns; quality of the local environment; and the number of takeaways on the high street), which were viewed as negatively influencing health behaviours. In contrast however, one child appeared to exhibit some resilience to negative features of the local environment (see Table 4.4).

4.5.2.2 Ethnic group specific themes

A small number of children made reference to their country of origin or their religious faith during interviews, and a small number of themes arose out of these discussions. The themes and example quotes are provided in Table 4.5.

Table 4.5 Ethnic group specific themes and example quotes

Theme	Example quotes
Status attached to traditional food practices varied by country of origin	• "I always eat my mum's food. And my country's food, I always eat – it has lots of carbohydrates and protein in it. We have rice, meat, that sort of thing." *ID14, Boy, Black African, UK born, 2 parents born abroad* • ID26: "Every Irani is eating rice" Interviewer: "And is that good or bad?" ID26: "Bad" Interviewer: "Why do you think it's bad?" [Discussion with translator] Translator: "Oil" … ID26: "That's Irani's habit" *ID26, Boy, Other ethnicity (Iranian), Non-UK born, 2 parents born abroad*
Differing body size ideals	• Interviewer: "And how do you think his [the unhealthy child's] body compares to other children?" ID2: "Because he's a little bit smaller than they are, and he doesn't eat healthy things, he likes eating lots of chocolate". Interviewer: "And what makes him small do you think? Why do you think he's small?" ID2: "Maybe because he is not healthy." Interviewer: "So do you think that smaller people are less healthy?" ID2: "A little bit. They just were born like it." *ID2, Girl, White other, UK-born, 2 parents born abroad* • "…well you need fat in your body because it's not good to just be… to have no fat, like at least a bit of fat. You don't want to be skin and bones. And the fruit and the veg and the meat, protein, and bread, carbohydrates, the fruit and the veg, just drop in a few sweets for the fatty and the sugars." *ID3, Girl, Black African, Non-UK born, 2 parents born abroad*
The influence of religious practices upon diet and physical activity behaviours	• Interviewer: "And what kinds of things do you have at the end of your [Ramadan] fast?" ID16: "We eat like, samosas, and we eat, sometimes we have like the healthy, like healthy foods like what my mum cooks. And we always have salads, and we always eat curries and that. And then for drinks we have orange juice, and what other drink you want, but not like… you can drink coke, but not like for every time. Like probably once a week, or twice a week." Interviewer: "And do you think the stuff that you have when you've finished fasting, is that healthy or unhealthy?" ID16: "It's healthy, but you don't need to fast all the time, that's just the beginning. You have to fast when you're 16." *ID16, Boy, Mixed Ethnicity (Black African and Arab), UK born, 2 parents born abroad* • "There's a school near them [the healthy child] and there's a park and there's their religious place, so then they won't have to like go a long, long way just to go to there." *ID27, Boy, Bangladeshi, UK born, 2 parents born abroad* • "…sometimes we go to the mosque and then when we come back we have three hours until it's bedtime. But I always spend this time drawing, enjoying TV… playing games and stuff… sitting down and having a rest." *ID19, Girl, Other ethnicity (Afghan), Non-UK born, 2 parents born abroad*

Theme	Example quotes
Migration: new contexts drive behavioural change	• "In my country, no one eating you know fruits, everyone eating fast foods in my country, fast food in restaurants. Restaurants Irani is, you know, my country, is not good." *ID26, Boy, Other ethnicity (Iranian), Non-UK born, 2 parents born abroad* • Interviewer: "So here, when you're in this country, is it easy to eat good [child's term to mean healthy] food? Or is it difficult to eat good food, here?" ID26: "It's easy. But in my country, no. Because you don't know, erm, how making food. And you know going shopping… Meat, when you taking meat in home, that meat for, you know today is 2016, that meat is from you know 2014. That's bad." *ID26, Boy, Other ethnicity (Iranian), Non-UK born, 2 parents born abroad* • Interviewer: "And what activities where there to do in Iran to keep you healthy? Compared to here? Could you do your running and your swimming?" ID26: "No I don't do that in Iran" Interviewer: "And why not?" ID26: "Because I'm going to go out, and you know the sun is so… I feel hot" *ID26, Boy, Other ethnicity (Iranian), Non-UK born, 2 parents born abroad*

4.5.2.2.1 Status attached to traditional food practices varied by country of origin

A small number of children identified with cultural food practices from other countries, using phrases such as *"my country's food"* (UK-born child with Black African ethnicity) and *"In my country…"* (child born abroad of Iranian ethnicity). Of those that discussed traditional or faith-based food practices (n = 3), one child appeared to give higher status to traditional foods i.e. when asked how he stays healthy; this child replied, *"I always eat my mum's food. And my country's food",* before describing his consumption of *"rice and meat"* (UK-born child with African ethnicity); whilst another child gave low status to his traditional cuisine, describing rice and oil as Irani's bad "habit" (child born abroad of Iranian ethnicity). Both of these children had two parents born abroad, and one child had recently migrated to the UK.

Following sub-group analysis, it was also apparent that there were ethnic group differences in the valuing of homemade food versus takeaway or convenience foods. For example, children from Black African and other ethnic groups more often identified 'fast food' or takeaways as unhealthy and considered homemade food as healthy (n = 2 out of 4 and n = 4 out of 9 respectively), compared to other groups (White British n = 0; White other n = 1 out of 3; South Asian n = 2 out of 6). On the other hand, viewing the occasional treat as part of a healthy diet was more often highlighted by Black African children (n = 3 out of 4) compared to other groups (White British n = 0; White other n = 0; South Asian =n = 1 out of 6; other n = 3 out of 9).

4.5.2.2.2 Differing body size ideals

Although most children viewed unhealthy children as generally overweight, others described unhealthy children as skinny, small or short. The view of small or 'skinny' children as unhealthy was particularly the case for those from White other backgrounds (n = 3 out of 3) and South Asian groups (n = 3 out of 6) compared to other groups

(White British n = 0; Black African n = 1 out of 4; other n = 1 out of 9). On the other hand, a low proportion of Black African and South Asian children described a healthy body as a 'muscly and strong' body, which was a common theme in the data of other children. It may be the case that there are differing body size ideals or differing levels of concern given to body size ideals across ethnic groups.

4.5.2.2.3 The influence of religious practices upon diet and physical activity behaviours

Religious practices appeared to have some influence over child health behaviours, although the exact influence was somewhat ambiguous.

For example, although some children described specific cultural or religious celebrations or commitments related to food and use of time (n=3), these children did not feel that these factors influenced their health behaviours. Two children talked about specific foods eaten during Eid celebrations, and these foods were a combination of items typically viewed as healthy e.g. fruit, homemade meals; and unhealthy e.g. fizzy drinks, fried foods. One child described dietary restrictions relating to Halal meat but felt that there was easy access to Halal food in their local environment, so in practice this did not affect their diet.

However, it was apparent from children's data that Eid was a period of relative permissiveness in relation to food e.g. *"I'm waiting for Eid and mum's going to give me anything I want",* and that hunger related to fasting resulted in increased desires for unhealthy food e.g. *"When I'm fasting at Ramadan, I really want to eat something bad".*

Commitment to attending mosque in the evenings appeared to influence the choice of activities in the after-school period. This commitment was mentioned by only one child in the current study, and this participant did not feel that mosque restricted their ability to take part in other activities, highlighting that there was time in the evening after mosque to fit in other activities. However, it was apparent from the data that the time following return from mosque was spent in sedentary home-based activities. Another child talked about not being able to dance *"because we are Muslim"*. This boy had recently migrated to the UK from Iran.

4.5.2.2.4 Migration: new contexts drive behavioural change

A small proportion of children were first generation migrants (n=6), however, only one child discussed experiences in their native country, and this was to draw contrasts between the UK and his home country. For this child, migration to the UK provided greater access to a healthy lifestyle, enabling a positive change in health behaviours. This was the result of macro-level influences such as the political-economic situation, climate and differing 'ways of life' in the UK versus his country of birth.

For example, this boy described a cultural preference for unhealthy food and fast food in his native country (Iran) compared to the UK e.g. *"everyone eating fast foods in my country."* He also discussed low availability and high cost of fruit and vegetables; an abundance of fast food; a lack of trustworthiness of food (e.g. food retailers falsely labelling Halal foods and selling out of date food); and limited opportunities to play outdoors due to limited space and a hot climate. In contrast, this child had high trust in the UK food industry, had easy access to Halal foods and low cost fruit and vegetables and was able to play outdoors. However this child did also identify anti-social behaviour that prevented him playing in his local park in the UK, suggesting that some barriers to physical activity remain.

4.5.3 Data sources: a comparison of drawings versus dialogue

Children's drawings were limited in depth, however, they supported analysis via the identification of the most prominent themes emerging in the data. These drawings emphasised the key findings relating to 1) the role of outdoor play in children's conceptualisations of physical activity;

2) the role of happiness in children's definitions of health; 3) gendered notions of physical activity (i.e. strength); 4) children's extreme views of obesity; and 5) the focus on personal responsibility for health.

However, many themes may not have been identified via children's drawings alone e.g. ideas around responsibility for health. For example, when asked to draw a picture of a healthy and unhealthy child and the things that help or cause healthy and unhealthy behaviours, the vast majority of children drew lone individuals. Only a small number drew pictures of additional people or societal elements that contribute, for example, a parent, a pet, a friend, a park, or a row of houses. This was in contrast to verbal interactions in which many children additionally discussed inherent, familial and social influences upon health.

Children generally valued the opportunity to draw, although some children preferred not to (with one child asking *"can I just use words?"*) or were not confident drawers. In addition, despite the intended use of drawings to better elicit children's perspectives, some children were still apparently tentative about giving their own perspective, and appeared eager to give the 'right' answer, which may suggest a certain degree power imbalance and social desirability in children's responses remained (Figure 4.9):

Figure 4.9 Child quote: Power imbalance and social desirability in the child perspective

> Interviewer: "So the first thing I'd like you to do is to draw a picture of a healthy child."
> ID11: "Eating fruit and vegetables?"
> Interviewer: "Well that's up to you. So if you picture in your head a healthy child, and think about the types of things that help to keep him or her healthy, and you can draw pictures, you can draw objects, you can write words if you like, if you don't want to draw you can just write."
> ID11: "Okay."
> *ID11, Boy, White other, Non-UK born, 1 parent born abroad*

The addition of researcher-participant dialogue (through the 'tell' element) also provided the opportunity to reassure children that there were no boundaries imposed on what they could or could not draw. This was evident by many children making adaptations to their pictures during or after verbal discussions.

The 'tell' element was also important for clarifying children's intentions, particularly when drawings were unclear to the researcher, and for enabling elaboration. This allowed for more accurate interpretation. For example, not all elements of children's drawings had 'meaning', as demonstrated by the following exchange (Figure 4.10):

Figure 4.10 Child quote: Meanings in children's drawings

Interviewer: "And how about this, he's got a question mark on his chest there, is that… or is that something else?"
ID3: "No, it's a question mark."
Interviewer: "Does that mean anything or is that just his t-shirt design?"
ID3: "I don't know. Because I was confused, I was like, hm, what shall I draw? I was like… but I think it looks good so I thought I'd just draw it on there."
ID3, Girl, African, Non-UK born, 2 parents born abroad

The added value that the "tell" element provided is also evident through the following drawing (Figure 4.11) and (dialogue Figure 4.12):

Figure 4.11 Child drawing: Picture of an unhealthy child

ID3, Girl, Black African, Non-UK born, 2 parents born abroad

Figure 4.12 Child quote: Added value of the "tell" component

Interviewer: "So you've drawn a picture of an unhealthy child there, can you tell me a bit about him?" ID3: "He's exactly like a normal child, exactly like it, it's just that maybe he's sad and he eats a lot, or he's just really hungry all the time. But it's really bad to a fat child, oh you're so fat, you have to lose weight, because it's really mean, and like they might cry because they're really sad because they're fat, they know it's obvious. Because they can see their own body and they don't need to have other people tell them. Some people are just too rude. And then just the exact same, but it's hard for a fat child to get healthy because they're scared that everyone will be like, ha, ha, ha, look he's so fat and your belly jiggles and your legs jiggle, and you might feel really ashamed of your body and then it's really hard. And children are evil… well most children are." *ID3, Girl, Black African, Non-UK born, 2 parents born abroad*

For this child, the drawing gave no indication that she viewed the 'unhealthy child' as overweight or unhappy. In this instance, the opportunity to 'tell' provided richness of data that was not detectable in the drawing alone.

4.6 Discussion

This study aimed to gain children's perspectives of the cultural and contextual factors that influence childhood overweight status in Coventry. Both universal and ethnic-group specific themes were found relating to children's' experiences, perspectives and beliefs around health, diet, physical activity and weight, which appeared to influence health behaviours.

4.6.1 Comparison to other literature

4.6.1.1 Universal findings

Some of children's conceptualisations of health have been observed in other qualitative research, for example, play as an opportunity for physical activity (Beets *et al.*, 2011; Brunton *et al.*, 2005), valuing of outdoor space (Eyre *et al.*, 2015b; Noonan *et al.*, 2016a), and the home as a space for sedentary behaviour (Eyre *et al.*, 2015b; Hume *et al.*, 2005).

Bullying and weight-based stereotyping was perceived as a barrier to physical activity in other qualitative research with adolescents (Stankov *et al.*, 2012). The current study suggests this may be a potential barrier in younger childhood as well as adolescence, for example through exclusion from play or sport due to low mobility and competency. In a qualitative study with 10-11 year olds in the UK, physical activity was linked to social status, particularly amongst boys (Jago *et al.*, 2009), so it is clear to see how children's perceptions of overweight children as immobile and less competent at sport may influence the low esteem with which overweight children are viewed as potential playmates.

The current study supports the findings of other research in identifying parents, friends and the school as key influencers. The value placed on family-based opportunities for physical activity has been observed in other studies from childhood through to adolescence (Brophy *et al.*, 2011; Brunton *et al.*, 2005; Eyre *et al.*, 2015b; Noonan *et al.*, 2016a; Rawlins *et al.*, 2013). The important role of friends in supporting positive health behaviours has been observed in both quantitative and qualitative research, although mainly for physical activity (Barkley *et al.*, 2014; Jago *et al.*, 2009; Jago *et al.*, 2010; Noonan *et al.*, 2016a; Salvy *et al.*, 2008). The current study found friends were also an important source of role modelling, encouragement and motivation for healthy dietary behaviours, in addition to physical activity.

Weather and safety (crime and traffic-related) consistently arise as a barrier to physical activity in research with children and parents, as in the current study (Brophy *et al.*, 2011; Brunton *et al.*, 2005; Eyre *et al.*, 2015a; Eyre *et al.*, 2015b; Irwin *et al.*, 2007; Noonan *et al.*, 2016a; Rawlins *et al.*, 2013; Robinson *et al.*, 2012). Concerns around safety can drive parents to restricting unsupervised outdoor play, a crucial source of physical activity for children in this study; and contributes the additional barrier of the reliance upon parental supervision for physical activity (Noonan *et al.*, 2016a), which is often difficult for parents to achieve

(Irwin *et al.*, 2007). The findings presented here suggest that these barriers appear to relate to the idea that children viewed physical activity as an outdoor pursuit, and in contrast, relate the home to sedentary pursuits.

The children participating in this study identified more facilitators than barriers to a healthy lifestyle, which is at odds with the findings of other qualitative studies with children (McKinley *et al.*, 2005; Rawlins *et al.*, 2013). The lack of barriers that children identified and the ease with which children felt health behaviours were possible may relate to the ways in which children conceptualised physical activity as fun (play) and health behaviours as largely driven by children's likes and dislikes (and therefore 'inherent' behaviours that require little thought).

Children in the present study highlighted the role of the mother in role modelling, motivating and enabling health behaviours. This is in contrast to the findings of Noonan *et al.* (2016a), who found that fathers were viewed as key role models for physical activity in particular, in a qualitative exploration of 10-11 year olds' perspectives. The potential difference between the effect of mother's and father's physical activity upon boys' and girls' physical activity (and the potential for gendered relationships) is unclear, but two reviews identified by Biddle *et al.* (2011) appear to support the idea that the father's physical activity is a more important correlate in children's activity than the mother's, at least for adolescents (Edwardson & Gorely, 2010; Gustafson & Rhodes, 2006). On the other hand, Jago *et al.* (2014) found no difference in the association between parental and child physical activity for boys and girls (aged 5-6 years) or between mothers and fathers. This latter study made use of objective measures of physical activity, however, missing data for both maternal and paternal physical activity levels may have hindered the identification of meaningful associations. It may be the case that mothers are viewed as facilitators within the domain of diet, whilst fathers act as their counterparts within the domain of physical activity.

Moreover, it could also be argued that the parental role model depends, at least in part, on the gender of the child, however, there is little research exploring this association in relation to diet or physical activity.

4.6.1.2 Ethnic group specific findings

Healthy and unhealthy traditional foods and faith-based food practices (related to Halal foods, fasting and Eid celebrations) were discussed by some children during interviews. However, given the ethnic diversity of the sample, and the large number of factors identified as influencing dietary behaviours in minority ethnic groups in other literature (Osei-Kwasi *et al.*, 2016), surprisingly few children reported food practices or beliefs related to their ethnicity. Of those that did discuss traditional foods (n = 3), two children had both parents born abroad, and one child had recently migrated to the UK. For these reasons, traditional foods may play a larger role in their lives compared to other children in the study. These children they may have a stronger sense of cultural and ethnic identity (for example, one Black African child whose parents were born abroad referenced his mother's food as *his* country's food too, despite being born in the UK himself). Cultural and ethnic identity have been identified as influencing dietary behaviours in minority ethnic groups by Osei-Kwasi *et al.* (2016). Retention of traditional food practices appear to be common and more valued in adults than children (Cross-Bardell *et al.*, 2015; Gilbert & Khokhar, 2008), which may be another reason for their lack of presence in the child data.

Other qualitative studies have highlighted the potential influence of ethnicity on physical activity in both adults and children (Eyre *et al.*, 2015b; Long *et al.*, 2009; Pallan *et al.*, 2012; Rawlins *et al.*, 2013; Trigwell, 2011). Attendance at Mosque as a barrier to physical activity in the evenings has featured more prominently in other qualitative research focused on South Asian populations, compared to the current study (Eyre *et al.*, 2015b; Hornby-Turner *et al.*, 2014; Pallan *et al.*, 2012).

4.6.2 Contribution to existing research

Through the privileging of children's perspectives, this research has identified new insights regarding both universal and ethnic group specific influences.

4.6.2.1 Universal findings

Other studies have highlighted children's holistic definitions of health, with an emphasis on psychological and social concepts (Piko & Bak, 2006). The current study proposes that the 'happiness' component of children's definitions of health operates bi-directionally as both a motivation for driving healthy behaviours and as a resource for enabling healthy behaviours.

The current study found stigmatisation, character judgements and apportioning of blame for obesity to be common place in children, generally with little regard for the social acceptability of such viewpoints. Similar findings have been identified by other qualitative researchers (Rees *et al.*, 2011; Trigwell, 2011), however the current study suggests that these negative value judgements are a result of the ways in which children moralised health as 'right' or 'good' and poor health as 'wrong'. The findings also suggest that the negative value judgements assigned to overweight status were permitted by a distancing of childhood obesity from children's own lives, and the 'otherisation' of obesity, driven by children's unrealistic perceptions of the 'obese body'.

The current study has revealed an interaction between behavioural preferences versus behavioural choices. For example, in relation to diet, children's belief that a healthy diet consists of some 'treats' and a degree of taste preference for such foods appeared to enable unhealthy dietary choices. Taste was also highlighted as a key barrier to eating healthily in other qualitative studies, with children prioritising taste over other factors (McKinley *et al.*, 2005; Thomas *et al.*, 2003). However, in the present study, some children reported prioritising the health values of food, despite a taste preference for less healthy foods, showing signs of reflective motivation (rationalisation of choices) in addition to automatic motivation (default behaviours) at this young age (Michie *et al.*, 2014), and an apparent rejection of the 'knowledge-behaviour gap' identified by Thomas *et al.* (2003).

In the present study, references to the influence of socioeconomic circumstances generally came from occasional mentions of the home environment (e.g. living in a block of flats) and material disadvantage (e.g. not owning a car), which were both seen as *enabling* physical activity. However, some implicit references to neighbourhood deprivation (e.g. descriptions of crime and safety concerns; quality of the local environment; and the number of takeaways on the high street) were viewed as negatively influencing health behaviours. Many studies have identified barriers to being healthy related to children's socioeconomic circumstances, but only a small number have done so from the perspectives of children, with such findings tending to come from researcher observations or comparative approaches rather than verbalised by children themselves (Backett-Milburn *et al.*, 2003; Eyre *et al.*, 2015b; Irwin *et al.*, 2007; Lofink, 2012; Pearce *et al.*, 2009). Given that the current study recruited exclusively from deprived neighbourhoods, this lack of explicit reference to children's socioeconomic circumstances may be due in part to what Backett-Milburn *et al.* (2003) identified as a downplaying of, and resilience towards material disadvantage. Alternatively, it may be due to children's lack of exposure to non-deprived environments, limiting children's ability to position themselves as 'deprived' or of 'low socioeconomic status'.

4.6.2.2 Ethnic group-specific findings

Sub-group analysis revealed that a 'healthy mind' may be a particular motivator for keeping healthy for children from South Asian or Black African groups, incorporating both academic achievement and mental well-being. Rawlins *et al.* (2013) identified a prioritisation of academic achievement in Indian children, but this was to the detriment of physical activity levels. Conversely, the children in this study viewed physical activity as a contributor to improved academic achievement and mental well-being.

Sub-group analysis also revealed a potential greater valuing of homemade foods for children from Black African and other ethnic backgrounds, which may imply that traditional food practices (typically homemade) are being retained in families from these backgrounds, despite such practices not being described explicitly in the data. A valuing of homemade food has been observed in South Asian and African-Caribbean families in the UK in other research as a result of the cultural significance of food in maintaining family and social networks (Higgins, 2008).

In the current study, children from South Asian and other ethnic groups appeared to have negative perceptions of a low body weight (viewed as unhealthy), and South Asian and Black African children did not appear to value 'strength' in the same way as other ethnic groups. These findings are however tentative, as they rely on 'counts' of qualitative data (for example the number of children referencing these ideas in their interview or drawings) which lack generalisability due to the qualitative nature of the study (discussed later in this chapter). Based on qualitative research with adults and parents (Lawrence *et al.*, 2007; Lucas *et al.*, 2013; Syrad *et al.*, 2014; Trigwell *et al.*, 2014), one might have expected to see more apparent differences in cultural valuing of larger body sizes across ethnic groups in children also, but this does not appear to be the case both in the present study and in others (Rees *et al.*, 2011; Trigwell, 2011). Researchers have found associations between high weight status and body dissatisfaction in South Asian children, rejecting the idea of a 'cultural valuing' of large weight status in this group (Pallan *et al.*, 2011). However, in a qualitative study by Trigwell (2011), children from Black

African, Bangladeshi and Yemeni ethnic groups also discussed positive physical traits associated with being overweight e.g. strength and 'cuteness', and Bangladeshi children appeared to express cultural preferences for overweight.

In general, it would appear that parents and adults may more readily discuss specific ethnicity-specific influences upon diet and physical activity behaviours and perspectives towards weight than children (Cross-Bardell *et al.*, 2015; Pallan *et al.*, 2012; Rawlins *et al.*, 2013; Trigwell *et al.*, 2015). There are two possible explanations: that children do not perceive ethnicity-specific influences upon health, or that the methods used were not able to elicit them.

Regarding children's perceptions of ethnicity-specific influences, the literature suggests that children's understanding of ethnicity as a social construct does not occur until 10 – 14 years of age (Quintana, 1999), although this may vary depending on exposure to ethnic diversity in day-to-day life. It may be the case the children in the current study were too young to consider their ethnicity as associated to their perspectives and experiences. Regarding a methodological explanation, studies that have identified ethnicity-specific influences upon health from children's perspectives have tended to use more in-depth approaches such as cognitive mapping, ethnography or multiple methods (Hume *et al.*, 2005; Irwin *et al.*, 2007; Lofink, 2012) or have made use of focus groups conducted in community venues such as places of worship (Rawlins *et al.*, 2013).

4.6.3 Strengths and limitations

The methodological strengths and limitations are discussed below, alongside a reflexive summary of how my positionality as a researcher may have influenced this research.

4.6.3.1 Key strengths

The key strengths of this research relate to the contribution the study makes to the existing evidence base. The use of a draw, write and tell technique allowed the child participants greater freedom and control to highlight issues with salience for them, achieving a more valid understanding of their meanings described in their own ways and words (Noonan et al., 2016). In the current study, comparison of children's drawings and dialogue showed that drawings alone were not adequate for children to fully express their perspectives. Although the use of drawings was useful as a way of engaging children and making them feel comfortable, this emphasises the importance of the 'tell' element of the method for adding richness to the data, a factor also noted by other users of the draw, write and tell method (Backett-Milburn & McKie, 1999; Mayaba & Wood, 2015).

In addition, the study attempted to be sensitive to children's rights by spending time ensuring children understood the nature of the research, gaining verbal consent and providing options for withdrawing. This study therefore makes a significant contribution to the gap in the existing literature highlighted by Rees et al. (2011) by privileging children's views via child-led methods. Studies of children's perspectives have also been criticised in the past for lacking attention to detail in the sampling and analysis, especially relating to ethnicity and socioeconomic status (Rees et al., 2011; Thomas et al., 2003). This study aimed to focus on ethnicity and socioeconomic circumstances *a priori* to understand how social, cultural and structural context influences child health and weight, enabling sampling and analysis to consider these factors from the outset.

4.6.3.2 Key limitations

Although an ethnically diverse sample was achieved (85% from non-White British backgrounds), a number of key ethnic groups in the local population remained unrepresented in the sample, including those from Black Caribbean, Chinese, mixed and Pakistani backgrounds, and the study sample could be considered too small for sub-group analysis based on ethnicity. The study's ability to identify key issues related to children's ethnicity may have been improved by the use of theoretical sampling (Silverman, 2014). Theoretical sampling would also have been particularly appropriate given the belief that data saturation had not been achieved. The lack of data saturation was evident in relation the role of migratory history (i.e. recent versus established migrants; country of origin) upon children's perspectives, and this acknowledgement, along with theoretical sampling which aimed to recruit additional participants on the basis of their migratory history, may have provided additional, valuable insights.

However, the sampling in this study was restricted by practical concerns including the time-frame for recruitment and low recruitment in some schools. In addition, ethnicity is a complex construct, incorporating ancestry, language, migratory history, culture, religion and physical characteristics (Mathur et al., 2013), making sub-group analysis on the basis of ethnicity difficult in qualitative samples. When combined with children's other characteristics e.g. neighbourhood deprivation, school attended, family affluence and structure, parental education, child's level of development / maturity and their confidence in a research setting, it becomes even more problematic to analyse and assign children's perspectives based purely on their ethnic grouping. Children's faith background was not collected in the present study which restricts identification of whether the sampling was adequate to identify practices related to children's faith. It was neither possible nor desirable to control for all of these potential influences upon children's perspectives and experiences, and on this basis, those provided in this study cannot be claimed to be representative of a single true 'voice' of children from deprived, urban, ethnically diverse UK populations.

No data on weight status were collected, and on this basis, it was not possible to assess if the sample included both healthy weight and overweight or obese children. This also prohibited the ability to consider how a child's weight status may have influenced their perspectives. The decision to not measure weight status was deliberate, as it was felt that this would be an additional barrier to recruitment; and in particular may have discouraged overweight or obese children from taking part.

Another limitation is the low response rates achieved from both schools and child participants. Reasons for non-participation from school leaders centred on a lack of time. An enthusiastic and engaged head teacher or classroom teacher was considered to be the essential ingredient for a high response rate from child participants, as this tended to result in active follow-up of parental consent forms. On this basis, there may have been a participation bias in the findings favouring schools (and children attending schools) that take an active interest in issues relating to child health and well-being.

Finally, the competency of participants may have played a role in my selection of quotes and images that supported the themes arising. This may have led to the over-representation of the perspectives of confident, articulate, expressive or mature children, and may downplay the experiences (or even lack of experiences) of other children, including those with language difficulties.

4.6.3.3 Reflexive summary

The findings presented are based on my interpretations and should be considered within the context of my epistemological stance and my personal characteristics as a researcher. For example, the fact that I am an adult attempting to research the views of children, and the interviews were conducted in schools, may have tilted the power imbalance between researcher and child, which could have resulted in the child providing the 'expected' or 'right' answer, as they perceive it (Hill *et al.*, 1996), and there was some evidence of this in children requesting permission to draw their pictures. As a White British researcher, children may have been less forthcoming about specific behaviours or traditions relating to their ethnicity if they were of a different ethnicity to me (Adamson & Donovan, 2002) and my own social and ethnic background could also result in failing to pick up on some important elements related to ethnicity and socioeconomic status because of my position as an 'outsider' (Ochieng, 2010).

4.6.4 Implications

Up-to-date research exploring children's perspectives plays an important role in intervention design (Thomas *et al*., 2003). Children's perspectives within this study support a number of recommendations made by others, such as designing health messages that are credible and relevant to children; school as a key setting for health education and promotion; providing opportunities for family participation; utilising friendship groups to support physical activity, and design of traffic-free open spaces for play (Beets *et al*., 2011; Brunton *et al*., 2005; Noonan *et al*., 2016; Pearce *et al*., 2014; Salvy *et al*., 2012; Thomas *et al*., 2003). In addition, a number of additional recommendations are proposed on the basis of children's perspectives from the present study. A summary of recommendations based on the key findings in this chapter is provided in Table 4.6.

Table 4.6 Recommendations for health promotion initiatives

Key findings	Recommendation
Driven mainly by social consequences of unhealthy behaviours, and some physical consequences	• Design of credible and relevant messages for motivating healthy behaviours based on the opportunity for making friends, ability to play, academic and sporting success, strength-building (for boys) and health for future success.
Stigmatisation of overweight children, use of negative terminology and extreme views of obesity	• Provide more realistic images of how overweight and obesity appears in the general population and degrees of overweight / obesity.
Physical activity conceptualised as play	• Package physical activity initiatives as opportunities for play.
Children as responsible for own health, agents of change and self-motivated	• Provide suggestions for how children can implement simple healthy behaviours in the home to influence the rest of the family; involve children in school decisions relating to health.
School-based programmes as memorable and influential, and the important role of teachers	• Continued use of school for health promotion and education delivery • Develop teacher's roles as health educators via training on use of positive reinforcement, conversation-starters on health and sensitivity in their interactions with children on diet, physical activity and weight.
Friends as influencers and motivators; overweight children have fewer opportunities to play	• Incorporate peer-support elements into health promotion initiatives / in schools in general, particularly for children identified as overweight.
Parents as role models, motivators and enablers for diets and physical activity behaviours (especially mothers)	• Increase opportunities to inform parents about their key role and provide suggestions for how to reinforce healthy behaviours via motivating statements and rule-setting. • Interventions aimed purely at improving parental health behaviours may positively impact upon children's health behaviours.
Enthusiasm for family-based physical activity and the role of local green space	• Introduction of more family-based physical activity initiatives, making use of local parks and packaged as opportunities for family-bonding
Indoor time as sedentary; bad weather and safety as barriers to physical activity	• Provide families with suggestions for ways to be physically active inside the home and information on the contribution of house-based activities to overall physical activity levels • Provision of traffic-free open spaces for independent play • Aim to improve children's and parents' resilience to poor weather conditions in relation to outdoor play

4.6.4.1 Cultural tailoring of interventions

There appeared to be little diversity in children's perspectives and experiences across ethnic groups, suggesting that cultural-tailoring of intervention messages and components may not be required for children directly (although may still be appropriate for parents). The exceptions were that the motivators for keeping healthy may differ across children from different ethnic groups. Messaging that incorporates the benefits of healthy behaviours for 'the mind' and for academic performance may have more salience for children from Black African backgrounds and South Asian backgrounds respectively. In addition, children's conceptualisations of a 'healthy body' may differ based on ethnicity, and interventions should attempt to establish individual children's body size ideals to address any unhealthy beliefs about weight. However, children from all ethnic backgrounds would benefit from more realistic images of what an 'unhealthy weight' looks like.

4.6.5 Remaining gaps in the literature

This study has contributed to the evidence base by exploring children's perspectives on health, diet, physical activity and weight in an ethnically diverse, deprived population, using methods that privilege children's views. There remain a number of gaps in the literature that this study identified but was not able to investigate.

Table 4.7 presents a number of suggestions for research topics that could be developed, explored (qualitatively) or examined (quantitatively) in the future to attempt to address these gaps.

Table 4.7 Recommendations for research

Mode of research	Recommendations
Development of tools or methods	• Methods for improving the elicitation of themes related directly to children's ethnic and social backgrounds, including how children's ethnic identity and acculturation profiles influence views
Explore via qualitative methods	• Gendered parental roles in relation to diet and physical activity (and differences for girls and boys) • Further exploration of perspectives of children from low socioeconomic versus high socioeconomic backgrounds through comparative studies • How children's weight status contributes to their views on weight, in particular, stigmatisation, stereotyping and use of terminology • A focus on the perspectives of children from specific ethnic groups, ensuring an adequate sample size to adequately represent views e.g. Pakistani, Black Caribbean • Parental views on how families' ethnicity and socioeconomic background influence their health, weight, diet and physical activity
Examine via quantitative or mixed methods	• The effectiveness of weight management and/or diet or physical activity interventions that incorporate elements suggested above (Table 4.6) e.g. a peer support element; a family-led approach

4.7 Conclusions

Using a child-centred approach, this qualitative exploration was able to uncover children's perspectives on how they conceptualised health, diet, physical activity and weight and apportioned responsibility for health. Through exploring key influences upon children's health behaviours, the study was able to identify barriers and facilitators to achieving a healthy weight. In addition, it was able to identify the many similarities and the small amount of diversity in children's perspectives and experiences across ethnic groups. Further research should employ methods that aim to explore these factors in more depth in specific ethnic groups and consider the perspectives of parents.

The findings suggest that childhood health promotion initiatives including obesity prevention, weight management and diet and physical activity interventions could focus on the existing assets that children describe, such as friendships and supportive family environments; emphasising health benefits framed by child-based motivations e.g. personal success and happiness.

These findings will be of interest to those working with families in Coventry and further afield, for the targeting of local resources; to public health analysts and researchers, who may value the child-led methods described; and to other researchers in the field, through the highlighting of directions for future research.

4.8 Chapter summary

This chapter outlines the conduct and findings of a qualitative exploration of children's perspectives and experiences of health, diet, physical activity and weight. This study has filled some of the gaps in the existing literature in understanding how cultural and contextual factors influence children's health beliefs and behaviours. The next chapter (study component 4) complements this study by exploring parental views and experiences of health, diet, physical activity and weight, which was one of the recommendations for future research identified above.

Chapter 5 Parental perspectives and experiences of family health, diet, physical activity and weight

5.1 Chapter outline

This chapter reports on the conduct and findings of a primary qualitative research study with parents in Coventry. Through this research, I aimed to fill some of the gaps in the literature identified in study component 1 (systematic review) and study component 2 (quantitative analysis) by using qualitative methods to explore the potential cultural and contextual basis of ethnic inequalities in childhood obesity in Coventry. The findings from study component 2 also provided valuable guidance for the sampling and design of data collection tools for this study component. This study is intended to complement study component 3 (qualitative research with children). In addition, the findings are explored in further depth in a mixed methods analytical integration of all study components in Chapter 6.

5.2 Background

The findings of the systematic review (Chapter 2) highlighted a general lack of research on potential determinants of ethnic group differences in overweight and obesity, and the potential for qualitative exploration to provide greater understanding of the cultural and contextual basis of such relationships. In addition to those identified in the review (but out of the scope of the review's research question), several other studies have explored adult, parental and child perspectives of health, weight, diet and physical activity in specific ethnic groups or in ethnically diverse populations and identified common barriers to keeping healthy such as religious practice and safety concerns (Cross-Bardell *et al.*, 2015; Eyre *et* *al.*, 2014; Lawton *et al.*, 2008; Ludwig *et al.*, 2011; Mu'Min Chowdhury *et al.*, 2000; Ochieng, 2013; Osei-Kwasi *et al.*, 2016; Pallan *et al.*, 2012; Trigwell *et al.*, 2015; Trigwell *et al.*, 2014; Vaughan, 2011). However, some gaps in the literature remain. For example, the mapping review by Osei-Kwasi *et al.* (2016) highlighted inconsistencies in the research regarding the interplay between SEP and ethnicity and found that few UK studies have included migrants from Sub-Saharan Africa. Trigwell *et al.* (2014) identified a need for further research on the role of culture in parental attitudes to overweight in childhood. In their study with African-Caribbean adults, Ochieng (2013) identified a need to explore how ethnic identity influences people's experiences of, and attitudes towards, a healthy lifestyle, and felt that such exploration should consider dynamic social contexts. In addition, Osei-Kwasi *et al.* (2016) called for research to explore both universal contributions to health behaviours as well as ethnic group specific ones. It may also be that traditional conceptual models of health, such as socioecological models (SEM), are not wholly applicable across all ethnic groups (Ludwig *et al.*, 2011; Osei-Kwasi *et al.*, 2016), although this has not been well explored within the context of childhood obesity. Eyre *et al.* (2013) also identified a need to investigate the perceptions of the local environment and the underlying mechanisms of its use for physical activity.

5.3 Study aims

The aim of the current study was to identify the cultural and contextual factors that influence childhood overweight and obesity in Coventry through an exploration of parental perspectives and experiences around family health, diet, physical activity and weight. The objectives were to understand:

- The knowledge, understandings, beliefs and motivations of parents around the concepts of health, diet, physical activity and childhood weight

- Parental reports of the dietary, physical activity and weight management behaviours within their families and the factors that influence these behaviours
- Parents' perceived barriers and facilitators to achieving a healthy weight within the family
- Parents' views on how to support local families to achieve a healthy weight
- Similarities and diversity in parents' perspectives and experiences in relation to ethnicity

5.4 Methods

5.4.1 Sampling and recruitment

The sampling frame was designed to consider ethnicity (of the parent) and weight status (of the child).

5.4.1.1 Sampling on the basis of ethnicity

Purposive sampling of parents was undertaken with the aim of exploring perspectives of childhood obesity in an ethnically diverse population in Coventry, with targeted recruitment of ethnic groups with the highest prevalence of overweight and obesity, as identified in the quantitative analysis of NCMP data (study component 2):

- Black African (due to high % ov/ob across both year groups)
- Black Caribbean (due to high % ov/ob across both year groups)
- Bangladeshi (due to high % ov/ob across both year groups)
- Pakistani (due to high % ov/ob in year 6)
- White other ethnic groups (due to high % ov/ob in year 6)
- White British (due to high % ov/ob in reception year)

On this basis, community organisations, parenting programmes, schools and faith centres in Coventry were approached to support targeted recruitment, with information packs distributed in person or through community gatekeepers. Gatekeepers were advised of the sampling aim so that they could target recruitment appropriately. Following distribution of study information packs, participants were asked if they were interested in hearing more about the study, and where participants agreed, a screening questionnaire collecting potential participants' contact details was completed and returned to the researcher (Appendix 22). Potential participants were then followed up by the researcher through phone call, text message or email, as preferred by the potential participant.

In community venues where a high response rate was achieved, parents were invited to participate sequentially on the basis of their ethnicity, in the order of ethnic groups listed above (as the groups at the top of the list had the most prolonged highest prevalence). Those from other ethnic groups not listed above were not excluded from taking part, and were invited to participate particularly in community venues where response rates were low (this convenience approach was introduced in order to achieve the required number for a focus group to be possible). In some community venues, additional participants were recruited by gatekeepers on the day to ensure focus groups were viable (had at least three participants), therefore not all participants completed a screening questionnaire.

5.4.1.2 Sampling on the basis of child weight status

An additional aim of sampling was to ensure the views of parents of both healthy weight and overweight or obese children were gathered. On this basis, information packs were also distributed by post (via the Be Active, Be Healthy, Be Happy team at Coventry City Council) to parents who had been invited to, or expressed an interest in, the One Body One Life (OBOL) weight management programme (a local family-based programme detailed in Chapter 1). The aim was that parents of overweight or obese children would be represented within the sample.

5.4.1.3 Consent procedure

Participant information sheets (Appendix 23) and consent forms (Appendix 24) were provided in advance and consent forms were collected / completed on the day of data collection.

5.4.2 Data collection

Semi-structured focus groups were selected as the main form of qualitative data collection, on the basis that a group environment can encourage participants to share stories and experiences and help to identify cultural values and norms (Pope & Mays, 2006). Focus groups were held in community venues at a date and time that suited each venue, and were scheduled to last one hour, aiming to include 3 – 9 participants per focus group. However, interviews can also be useful for exploring potentially sensitive issues. As such, it was judged that their inclusion as a means of data collection would support the recruitment of those who dislike group interaction, hence one-to-one interviews were offered as an alternative for those not wishing or able to attend a focus group.

All focus groups and interviews were organised and facilitated single-handedly (personally) with the exception of one focus group (focus group 1), in which a colleague assisted in participant greeting and administration, and in note taking during the focus group. Focus groups were structured as follows:

1. Greeted participants, offered refreshments and collected consent forms
2. Assembled the group so all participants were seated in a circle
3. Began focus group (approximately one hour), audio recording and field notes
4. Post-interview questionnaire distributed and collected (see section 5.4.2.1.2)

The approach to dealing with group dynamics within focus groups was guided by Barbour (2007). For example, during facilitation, I attended to the balance of dominant and subordinate personalities within the flow of the conversation, paying particular attention to the influence the interactions between participants. I aimed to ensure a range of voices were heard through my methods of facilitation e.g. open body language and verbal prompts were used to encourage full interaction from all participants.

5.4.2.1 Data collection tools

5.4.2.1.1 Topic guide

A topic guide was developed based on a socioecological model of childhood obesity (Sallis *et al.*, 2008) and was informed by gaps in the existing literature (Appendix 25). The use of the SEM ensured that questions and prompts were included that aimed to explore the potential multiple levels of influence upon families' behaviours, in particular, considering barriers and facilitators to health behaviours 'beyond family life' (i.e. friends, wider family, community, school, local area, government, media and society) and the role of culture and community in shaping knowledge and beliefs (i.e. *do others in your community think the same as you?*), A summary of the topic guide can be found below in Figure 5.1.

The principles guiding the design of the questions were: avoidance of technical language; avoidance of leading questions; avoidance of questions that imply any judgement of the participant or an issue discussed during data collection; the inclusion of open questions; and the use of probing to access examples of experiences (Greene & Thorogood, 2014).

Figure 5.1 Summary of topic guide for parent focus groups and interviews

Opening questions
In turn, please tell the group your name, where you are from and complete the following sentence: "To me, being a healthy family means…"
How do you know / how did you learn what was healthy and unhealthy? How do your children learn about it?
How about weight? How might a person's weight influence their health? OR You have mentioned weight – can you explain more?

Perceptions and social norms
How healthy do you think your family's diet is?
How physically active is your family?
How do you think it compares to other families?

Culture, traditions, roles
Can you tell me about the role of food within your family?
Can you tell me about the role of physical activity within your family?

Facilitators and Barriers
What opportunities are there for you and your children to be healthy in your day-to-day lives? How easy is it?
What gets in the way of being healthy for your family?

Wider influences
Beyond family and life, what else influences the diet of your child?
Beyond family and life, what else influences the physical activity your child does?
As a child, was your lifestyle similar to your own children? What has changed for children now? How is life different?

Motivations and intentions
How important is it for you and your family to be a healthy weight?
What would you change about your family's diet and physical activity?
How confident are you that you could do those things? Does it seem achievable?

Support
Who you think is responsible for preventing childhood obesity?
What should they do to help prevent obesity?
What else needs to be done to prevent childhood obesity?
What should parents do, if anything, to help reduce obesity?

5.4.2.1.2 Participant data collection forms

A screening questionnaire was used to support appropriate sampling and recruitment, collecting ethnic group based on census categories (Appendix 22). A self-administered questionnaire was also conducted post-interview, collecting parental gender, age, education, faith, number of children, country of birth and languages (Appendix 26). A free text box was provided in this questionnaire for participants to describe their ethnicity in their own words. The rationale for using both census category-defined ethnicity (in the screening questionnaire) and self-defined ethnicity (in the post-interview questionnaire) was to: 1) ensure adequate sampling of ethnic groups based on the pre-defined ethnic groups identified as high risk from NCMP analyses, and 2) allow for exploration of ethnic identity and its impact upon the findings by allowing parents to self-define their ethnicity. Both questionnaires were piloted for comprehension in a multi-ethnic group at a Children's Centre in Coventry.

5.4.2.1.3 Audio recordings, field notes and reflective journal

All focus groups and interviews were audio-recorded. Field notes were also taken during and after data collection, including descriptions of where participants sat to support identification of their data. The field notes supplemented data collection as a contextual reference, used alongside data transcripts. A reflective journal was also used throughout data collection and analysis, for example, in reflecting on major themes arising in each interview and focus group, on participants' interpretations of questions, and on participant-researcher interactions. This was used to help reflect upon the potential influence of personal values upon interpretation of the data, and supported the construction of a reflexive summary (section 5.6.3.3). Interactions between individual participants and observations on group dynamics were also recorded in the reflective journal, and these dynamics were considered consequentially in the data generated.

5.4.3 Data preparation and analysis

Each participant was allocated an individual ID number post-focus group/interview. Focus groups and interviews were transcribed verbatim. Some interviews were transcribed by the researcher (n=8), whilst others were transcribed by an external transcription service (n=7). For those transcribed by an external service, accuracy of transcripts with audio recordings was checked by the researcher. Participants were also assigned an ID number relating to their focus group in order to retain the context in which their data arose. The field notes were transcribed and appended to individual transcripts, as a contextual reference.

Data analysis was concerned with both the data generated by individual participants (in order to consider the influence of characteristics such as ethnicity and gender), as well that generated for each focus group unit (in order to understand the ways in which the data generated were co-constructed in a collective way). This was achieved firstly by assigning individual ID numbers to each utterance in the transcripts (this was done retrospectively for those transcribed by an external service), assisted by field notes to support the recall and identification of individuals on audio recordings (e.g. seating plans; personal features of note such as voice pitch or accent). Secondly, this was facilitated in NVivo by coding each individual participant's data as a case node, in addition to the thematic coding undertaken for each transcript (see below). Finally, focus group dynamics were considered in the reflexive summary (section 5.6.3.3).

Framework analysis was conducted based on the process detailed by Gale *et al.* (2013) and is summarized in Figure 5.2.

5.4.3.1 Coding

Free coding was used to note preliminary thoughts on broad codes arising in the data. These were then reviewed and refined as more transcripts were coded, adding new codes as necessary until no new codes arose. Codes were then grouped into categories and sub-categories. As in study component 3, the SEM was used as a conceptual guide to coding, e.g. codes in the category 'suggestions for support' were organised by macro-level interventions; family and community-level interventions; and one-to-one support. As in study component 3, this was done inductively and informally. Meetings were held with RJ, FB and WR to discuss the coding framework and provide quality assurance. Once a coding framework was finalised, transcripts were imported into

NVivo v11 alongside typed field notes and reflective notes, and the full set of transcripts were systematically coded (or re-coded if necessary) using the framework.

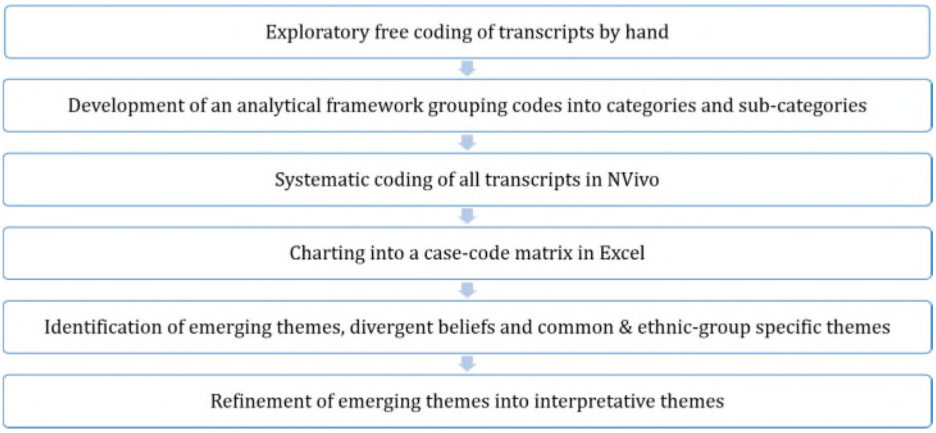
5.4.3.2 Charting and emerging themes

Data for each participant and each code were then summarised and charted into a case-code matrix (participants in rows and codes in columns). This overview was used to understand *'emerging themes'*, identify divergent beliefs and views, and seek both common themes across all groups and those unique to specific ethnic groups. The case-code matrix was also organised by ethnic groupings to support identification of universal and ethnic-group specific themes. Analytical memos were written to develop the emerging themes through grouping, linking and summarising the codes alongside segments of data.

5.4.3.3 Interpretative themes

Finally, these emerging themes were studied and refined into final *'interpretative themes'* that went beyond descriptive analysis by seeking possible explanations for what was happening within the data from the perspective of the participant. Interpretative themes are reported in the results below, supported by quotes, with the previous few lines of data presented where necessary for context (Kitzinger, 1995) along with participant descriptions. These participant descriptions consisted of: 1) ID number; 2) self-defined ethnic group; 3) country of birth; and 4) faith.

Figure 5.2 Analytical process diagram



5.5 Results

5.5.1 Sample description

260 participant information packs were distributed across eight settings (four community/faith centres, two schools, one parenting programme and one weight management programme). Six focus groups and seven interviews were undertaken with a total of 35 participants, as detailed in Table 5.1 alongside focus group characteristics. Although the aim was for focus groups to be homogenous based on broad ethnic groupings (in order to facilitate focused discussion of cultural influences relevant to specific ethnic groups), in practice this was not possible (see section 5.6.3.2). Of those six focus groups conducted, three were conducted with participants from African and Caribbean backgrounds (groups 1-3), two with those from South Asian backgrounds (largely Pakistani, groups 5-6), and one mixed (largely White British, group 4).

Table 5.1 Focus group and interview characteristics

Data collection method	N	Target group for recruitment	Venue and timing	Location
Focus group 1	3	Black Caribbean/African	Faith centre 1 Weekday evening	Wood End
Focus group 2	3	Black Caribbean/African	Faith centre 1 Weekday evening	Wood End
Focus group 3	3	Black Caribbean/African	Faith centre 2 Weekday lunch time	Longford
Focus group 4	7	White British / White other	Community centre Weekday day time	City Centre
Focus group 5	9	South Asian	School Weekday day time	Foleshill
Focus group 6	3	South Asian	Community centre Weekday day time	Foleshill
Interviews	7	Mixed	Mixed	City-wide
Total	**35**			

Participant characteristics are provided in Table 5.2. Self-defined ethnicity (free-text descriptions) is also provided and linked to quotes in section 5.5.2. Assigned census category descriptions are also provided and link to the 'sample description' provided in Table 5.3. Census category assignments were based on participant responses to the screening questionnaire (in which participants were asked to select ethnicity from census categories). However, a large number of participants did not complete this information (n=16), so self-defined ethnicity was matched to a census category in this case where possible. If self-definedd ethnicity did not match to a census category directly, the participant's ethnicity is described as 'not stated' in Table 5.3 (n=3). This was generally the case when participants left early and did not complete a post-interview questionnaire. Self-defined ethnicity sometimes differed from census category selections e.g. when participants described themselves as 'Black African' when using census categories, but 'African' when using self-description.

Table 5.2 Participant characteristics

ID	Interview /focus group	Parental status	Ethnicity	Country of birth	Faith	Primary language	Weight status	IMD Decile	Educational level	Census category
ID1	Interview 1	Mother	Black British African	Kenya	Christian	Swahili	Obese	7	Vocational	Black African
ID2	Interview 2	Mother	Black African	Zimbabwe	Christian	Ndebele	Overweight	5	Degree level or above	Black African
ID3	Focus group 1	Mother	Black African	Cameroon	Christian	French	Overweight	10	Not stated	Black African
ID4	Focus group 1	Mother	Black African	Non-UK born	Christian	French	Overweight	10	Prefer not to say	Black African
ID5	Focus group 2	Mother	Black British	UK	Christian	English	Not stated	10	Prefer not to say	Black Caribbean
ID6	Interview 3	Mother	African	Sudan	Muslim	Arabic	Overweight	10	GCSE or O Level	Mixed Other (African/Arab)
ID7	Focus group 2	Mother	African	Nigeria	Christian	English	Obese	7	Vocational	Black African
ID8	Interview 4	Father	Black African	Angola	Christian	Portuguese	Not overweight	10	Degree level or above	Black African
ID9	Interview 5	Mother	Black African	Non-UK born	Christian	English	Not overweight	8	Other	Black African
ID10	Focus group 1	Father	Black African	Angola	Christian	Portuguese	Overweight	Not stated	Other	Black African
ID11	Focus group 2	Mother	Gambian	Gambia	not stated	Fula	Not stated	10	No qualifications	Black African
ID12	Interview 6	Mother	Black African	Zimbabwe	Christian	Ndebele	Not stated	10	Degree level or above	Black African
ID13	Focus group 3	Mother/ Grandmother	African Caribbean	Jamaica	Pentecostal	English	Obese	10	GCSE or O Level	Black Caribbean
ID14	Focus group 3	Not stated	Not stated	Jamaica	Christian	English	Not stated	8	GCSE or O Level	Not stated
ID15	Focus group 3	Mother	Black African	Nigeria	Christian	English	Obese	10	Degree level or above	Black African
ID16	Focus group 4	Mother	White British	UK	Christian	English	Not overweight	4	Degree level or above	White British
ID17	Focus group 4	Mother	English	UK	Christian	English	Obese	8	Other	Other (English)
ID18	Focus group 4	Father	British White	UK	No religion	English	Overweight	2	Degree level or above	White British
ID19	Focus group 4	Mother	African	Kenya	Christian	Kikuyu	Not stated	9	Degree level or above	Other (African)
ID20	Focus group 4	Mother	White British	UK	Christian	English	Not overweight	8	Degree level or above	White British

ID	Interview /focus group	Parental status	Ethnicity	Country of birth	Faith	Primary language	Weight status	IMD Decile	Educational level	Census category
ID21	Focus group 4	Mother	Mixed Caribbean	UK	Christian	English	Not overweight	Not stated	Degree level or above	Mixed Other
ID22	Focus group 4	Mother	Arab British	Syria	No religion	English	Not overweight	9	Degree level or above	Arab
ID23	Interview 7	Mother	Pakistani	UK	Muslim	Urdu	Not overweight	4	Vocational	Pakistani
ID24	Focus group 5	Mother	Asian Indian	UK	Muslim	Gujarati	Not overweight	10	Degree level or above	Indian
ID25	Focus group 5	Mother	Muslim	Pakistan	Muslim	English	Not stated	9	Not stated	Other
ID26	Focus group 5	Mother	British Muslim	Pakistan	Muslim	Urdu	Not stated	10	Prefer not to say	Other
ID27	Focus group 5	Mother	British Muslim	UK	Muslim	English	Overweight	10	GCSE or O Level	Other
ID28	Focus group 5	Mother	Muslim	Pakistan	Muslim	Urdu	Not stated	9	Not stated	Other
ID29	Focus group 5	Mother	British Muslim	UK	Muslim	English	Not stated	10	GCSE or O Level	Other
ID30	Focus group 5	Mother	Pakistani	UK	Muslim	English	Obese	10	Vocational	Pakistani
ID31	Focus group 5	Mother	Not stated	Not stated	not stated	Not stated	Not stated	Not stated	Not stated	Not stated
ID32	Focus group 5	Mother	Not stated	Not stated	not stated	Not stated	Not stated	Not stated	Not stated	Not stated
ID33	Focus group 6	Mother	Pakistani Muslim	Pakistan	Muslim	Urdu	Not stated	8	GCSE or O Level	Pakistani
ID34	Focus group 6	Mother	Asian British	Kenya	Christian	English	Obese	10	Degree level or above	Indian (British Asian)
ID35	Focus group 6	Mother	Indian	UK	Sikh	Punjabi	Not stated	9	Not stated	Indian

Table 5.3 Sample description

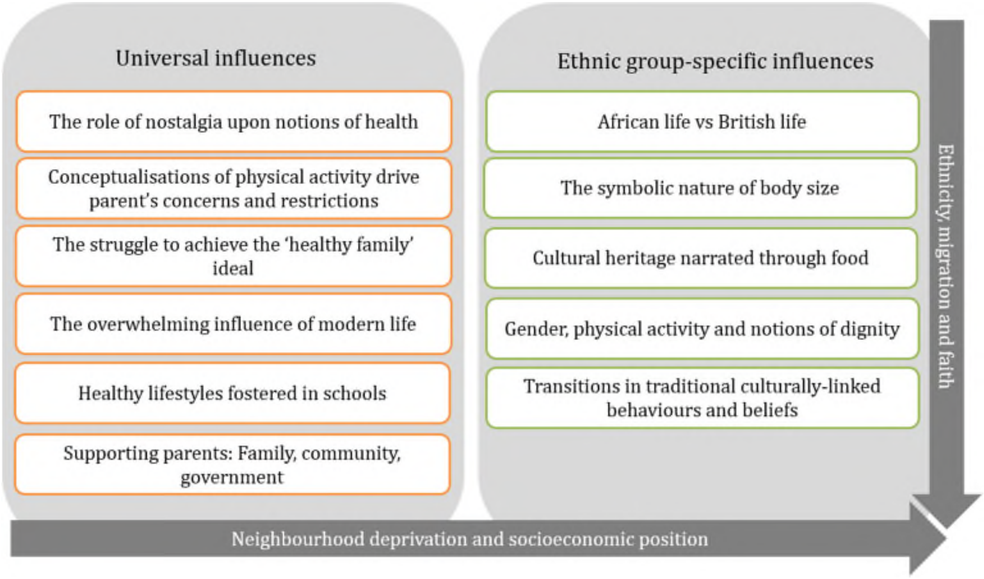
Gender	n
Female	31
Male	3
Not stated	1
Ethnic group (census category)	
White British	3
Indian	3
Pakistani	3
Black African[1]	11
Black Caribbean	2
Mixed other	2
Arab	1
Other[2]	7
Not stated	3
Country of birth	
UK born	12
Non-UK born	21
Not stated	2
Education	
Degree level or above	12
Vocational (BTEC/NVQ/Diploma)	4
GCSE or O Level	6
Other	3
No qualifications	1
Prefer not to say	3
Not stated	6
IMD Quintile	
5 Most deprived	20
4	7
3	1
2	2
1 Least deprived	1
not stated	4
Weight status (self-reported weight and height)	
Not overweight	8
Overweight	7
Obese	7
Not stated	13
Total	35

[1] Includes Kenya, Zimbabwe, Cameroon, Nigeria, Angola, Sudan & The Gambia
[2]'Other' refers to those not selecting census categories, and included: 'British Muslim' / 'Muslim', 'English' and 'African'

5.5.2 Interpretive themes

72 codes were initially identified and formed the basis of transcript coding and the case-code matrix, which were further refined into 61 codes upon reviewing the case-code matrix and merging 'over-lapping' codes. Interpretation of these codes resulted in 11 interpretative themes, summarised in in Figure 5.3. Example quotes in support of themes are provided in tables, and some illustrative terms and phrases also provided in the body of the text below.

Figure 5.3 Summary of interpretative themes



5.5.2.1 Universal themes

The universal themes with example quotes from parents are provided in Table 5.4.

Table 5.4 Universal themes and example quotes

Theme	Example quotes
The role of nostalgia upon notions of health	"It's not even safe though, you know how it used to be when we were younger. It's not like that anymore. You've got to think twice before you let them go to the park, but with us, it was like coming back home at 8 o clock, and my dad used to come and say 'right time to eat now'. And come home. You know, we were out in that park every time on our bikes, playing on our bikes, cricket, everything. So many activities." *ID29, mother, British Muslim, country of birth: UK, faith: Muslim* "There's been so much changes in society. Because I've been in this country since I was ten years old, ten, eleven years old, and I've seen so much change. I can go back and talk to my children about… back in the 60s and 70s, there was this and that, and that was the good old days, and they're fascinated. Because it was a healthy way of living, there wasn't so much murder, there wasn't much thieving. It was there, but not as wide as it is now. Our homes, you could leave the windows open. You could leave the door open. And go to town and come back. And the neighbours were friendly, it was a more community spirit." *ID14, mother, ethnicity not stated, country of birth: Jamaica, faith: Christian* "I think in the modern, like now, we've kind of lost that. Like erm, in the olden days people used to eat together as a family. You would come together, sit at the table, and eat, no TV, no phones. And that's a way of bonding as a family. But I think we've lost that. And for me that is how I would like my family to be. But that's wishful thinking, it's not going to happen. But we still bond over food sometimes like for Sunday dinner. That's when we kind of find ourselves sitting together enjoying a meal. *ID19, mother, African, country of birth: Kenya, faith: Christian* There's no sort of family unit I think, has also contributed to the environment of the… the breakdown of the family. So that in itself makes it that you will have children eating just what they like and mothers buying that just because it's easier. Because it's not a family, not a gelled family life. *ID13, grandmother, African Caribbean, country of birth: Jamaica, faith: Pentecostal*
Conceptualisations of physical activity drive parent's concerns and restrictions	ID9: "They don't really stay active. It's like now, if I should pick them up from school, we go home, eat something, that's it. We don't go out, or we don't do anything. Even weekends, they don't really stay active. The weather is bad, you don't want to go out in the rain, you don't have anywhere in particular to go. Even if you are going there, you are thinking about the cost of going there, and the frustration. Like, whether it's going to rain, are you going to get the bus to get there on time… it's, oh god." [Interviewer]: "There's a lot to think about?" ID9: "Yeah. And then you just go, stay at home. And you think about the distance of going there" *ID9, mother, Black African, country of birth: Non-UK born, faith: Christian* "Yeah it's cold a lot in this country. So you don't want to go out in the cold. You want to snuggle up and watch a film. So you watch a film and eat unhealthy food at the same time." *ID21, mother, Mixed Caribbean, country of birth: UK, faith: Christian* [Interviewer]: "So is there anything else that gets in the way of being… of the children doing active things?" ID1: "The telly and their games and their phones [laughs]. I try and monitor that but it's like sometimes like you want that quiet in the house [laughs]. Well I'm guilty of it, I won't lie, I like the quiet in the house." *ID1, mother, Black British African, country of birth: Kenya, faith: Christian*

Theme	Example quotes
The struggle to achieve the 'healthy family' ideal	"It's quite important because it's sort of like, you know, a gathering time where we all seated in one place and can enjoy each other's company and talk about your day. So really it's quite important because that is the time when we're all together." *ID2, mother, Black African, country of birth: Zimbabwe, faith: Christian* "I work night shift sometimes, I don't have time to sit with her then do all those exercises. I'll be really tired, so I need time to sleep. And when I wake up it will be time for me to go back again to work, just quickly do something, eating then I'm back again." *ID12, mother, Black African, country of birth: Zimbabwe, faith: Christian* ID22: "As a single mother, for me it is very difficult to do exercise, go walking, because most of the time, when she's sleeping, I'm finished. So it's difficult." [Agreement] [Interviewer]: "You're just tired?" ID22: "I am father, mother, whole family for my baby. I lost this. My body is getting too much too exhausted, very easy. Yeah." *ID22, mother, Arab British, country of birth: Syria, faith: No religion*
The overwhelming influence of modern life	ID29: "We've got too many takeaway shops haven't we? I know you don't force anyone to go in, but 'oh wow, chicken and chips, a pound'" ID30: "It's the easy option isn't it?" ID27: "Yep. Easy option. Sometimes when you've just left work, you're tired, you don't want to cook, go get yourself a bag of chips. ID29: I'm not gonna lie, I usually do that!" *ID29, mother, British Muslim, country of birth: UK, faith: Muslim; ID30, mother, Pakistani, country of birth: UK, faith: Muslim; ID27, mother, British Muslim, country of birth: UK, faith: Muslim* "I'm sorry, manufacturers are to blame, and government, because you go to the shop and the first things you see are so enticing – you see all the cakes, you see all the sweeties, and the little children, they're going to want… you know. So the manufacturers are pushing. They're getting richer, the children are getting unhealthier." *ID14, mother, country of birth: Jamaica, faith: Christian* "I think obviously it's been years of debating like some adverts should be banned, but you can't do anything with that. But like fast food restaurants, you know, they will always be there for god knows how long." *ID1, mother, Black British African, country of birth: Kenya, faith: Christian*
Healthy lifestyles fostered in schools	"His school has got erm, lots of space for him to run around, they've got things to, where they have to, they've got climbing things. They've got places where you balance. Like erm obstacle courses and stuff. And they do, in PE, they do a lot of different sports, you know, they try different things. And they encourage them sometimes, when they weather is nicer, they get prizes, they get a prize if they walk to school, like every day that week. So they encourage them to walk to school as much as possible. When it's not horrible. So you know the school are all really good at that. Getting them to be active, and the food he has at school and dinners, that's all healthy, and they always have a salad bar. And they make sure that if they're on the packed lunches, they've got to have certain… they can't have certain things. So his school is really good for the healthy things." *ID17 mother, English, country of birth: UK, faith: Christian* ID27: "The only activity they get is school." ID29: "School. And then they're at home on their phones or iPads or games" *ID27, mother, British Muslim, country of birth: UK, faith: Muslim; ID29 mother, British Muslim, country of birth: UK, faith: Muslim*

Theme	Example quotes
	"I must admit that after school club and within-school club and before-school club, now, has really helped the children. And I think at least the government or the council are trying to make sure. I think they've been a massive help now, than years ago, and I think there is a lot of awareness now about it. Because there are so many programmes. Like when I come back from OBOL, the day I don't go to work, my kids are telling me, there's a programme we watch and 'we can't eat this, we can't eat that' so the kids are learning even more." *ID7, mother, African, country of birth: Nigeria, faith: Christian* "My son, he's in secondary and he will be like, 'oh all my friends get chips after school', and I'm… and he's like, 'mum can I have some money to buy chips after school'. And I'm like, 'do you think that's really a good idea, wouldn't you rather come home and eat home cooked meal?' 'But all my friends…'" *ID1, mother, Black British African, country of birth: Kenya, faith: Christian*
Supporting parents: Family, community, government	ID12: "We've taken part in an exercise, One Body One Life which we did by my daughter's primary school. So we were taught healthy things, the things that are healthy, the things that we can prepare for the family and things that are affordable to get in the shops. And you can also prepare meals that are not high in fat, that are not high in all sorts of things that are a disadvantage to our bodies." [Interviewer]: "Yeah, so that helped going on that programme." ID12: "It really did help a lot, you know, we did have some changes in the house. We're reducing the oil we use to cook, you know, reducing the fat as well and buying healthy foods. Like we are eating more fruits than we used to, too." [Interviewer]: "More fruits?" ID12: "More fruits. And we are also drinking water a lot, we are exercising a lot instead of go walking. Instead of going on the bus sometimes, you know, going to just nearby places, we just walk. And we take some time, like weekends we walk to Asda that is behind our house. We've changed so many things." *ID12, mother, Black African, country of birth: Zimbabwe, faith: Christian* "I think sometimes, even if the community just organises something, or we just all get together and whatever equipment they've got at home for children to play with, they can bring that. Like today we'll have a cricket match between parents and children. And next week we can have something else. I think that will make quite a lot of difference as well, because as a parent, my friends, we've actually organised that and it has went well. It was like, we did like a ladies day, and then we did mothers competing with the fathers. So it was quite a good activity, quite a fun one. So the children really enjoyed it, obviously you could tell who was supporting which parent. So I think as a whole community, if people get together, then they can make an influence on the children in that way as well, bring the community together." *ID23, mother, Pakistani, country of birth: UK, faith: Muslim* ID30: "I think the food as well, the way they do the amber now, and the green, and the red, the traffic lights. I think that helps as well, you know with the food labelling. That helps them make more healthy choices, because like, they look at the food then and they say, oh no, that's got red in it, we don't want to buy it. We don't want that. I think that helps in some ways as well." ID24: "And for us, as well" ID30: "And for us, yeah. Because before that it was all writing at the back wasn't it? And you had to read it. Like a chart thing. But now with the, it's really quick to sort of quickly scan what's good and what's not." *ID30, mother, Pakistani, country of birth: UK, faith: Muslim; ID24, mother, Asian Indian, country of birth: UK, faith: Muslim*

5.5.2.1.1 The role of nostalgia upon notions of health

Parent's conceptualisations of health appeared to be derived from nostalgia for the past and their own childhoods. This was evident through the contrasting ways in which parents described childhood, both their own and their child's, and the emotions attached to these descriptions. For example, parents used terms such as *"freedom"* and *"friendly"* to describe their own childhoods, and terms such as *"afraid"*, *"scared"* and *"trust"* to describe their children's childhoods.

This nostalgia was intrinsically linked to parent's ideals about healthy dietary practices- which were centred on homemade, family meals- and to conceptualisations of physical activity: as an outdoor pursuit. Modern demands of employers upon employees and changes in societal values were seen to contribute to the breakdown of the family unit. Coupled with increasing expectations about convenience, this was seen to result in fewer family meals and a reliance on convenience foods. A global change in lifestyles with greater availability and reliance on technology contributed to the notion of 'digital childhoods', experienced by their own children. In addition, parents felt that danger and mistrust had become an ever-present feature of modern society (although parents acknowledged that this was a perception driven by traditional and social media). Accompanied with a loss of the sense of local 'community', this restricted the extent to which their children were able to play independently outdoors. This was in stark contrast to the 'childhood freedoms' described in parent's own childhoods. Phrases such as *"they're not like kids anymore"*; *"[it] is not a good world now. We are afraid…"* and *"I'm so sad, I say that because they* [my children] *don't have freedom to play outside"* further indicate the contrasts between parent's and children's childhoods.

5.5.2.1.2 Conceptualisations of physical activity drive parents' concerns and restrictions

Two key 'spaces' had an influence over the physical activity behaviours of children: 1) the neighbourhood and the outdoors; and 2) the home. At the core of these spheres of influence was parents' conceptualisations of what it means to be physically active: physical activity tended to be viewed as an outdoor or external pursuit, whilst the home was viewed as a space for rest and relaxation, lending itself to sedentary pursuits. Sedentary life was also associated with unhealthy dietary habits e.g. *"you watch a film and eat unhealthy food at the same time".*

These conceptualisations appeared to drive the barriers and facilitators that parents identified in relation to children's physical activity. For example, low availability and high cost of local leisure facilities, unsafe and unattractive playgrounds and a lack of open green space; and safety concerns were all key barriers to physical activity for families. Parents also felt that the climate, daylight hours and weather conditions affected family physical activity levels.

In exceptions to this conceptualisation, some parents viewed household chores as contributing towards physical activity; and some described efforts to be physically active in the home environment.

5.5.2.1.3 The struggle to achieve the 'healthy family' ideal

As described earlier, parents' ideals about family life seemed centered around healthy behaviours: family mealtimes and family-based activities, which were often described as physically active pursuits. Keeping children healthy was embedded in parents' (especially mothers') ideas about what it means to be a good parent, and parents were highly motivated to provide these family ideals for their children.

However, these ideals were far from achievable for most families. Desire for minimising the complexity of day-to-day life and the ease of opting for default/habitual behaviours often overrode parental intentions. Family life was viewed as busy, and parenting was considered physically and emotionally demanding. Good intentions were often side-lined for quick, easy options requiring minimal cognitive and physical effort. This meant allowing children to be sedentary and a reliance on convenience and takeaway foods. Parents reported how their children's use of digital technologies in the after-school period at home helped relieve some of the pressures of balancing parenthood and work.

5.5.2.1.4 The overwhelming influence of modern life

There was a strong feeling that modern society was not supportive of a healthy lifestyle and created a sense of a lack of control over one's ability to provide a healthy lifestyle for the family. This included the culture of an unhealthy work-life balance, the role of the food and retail industry and food marketing, reliance on technology, poor infrastructure, the dangers present in society (e.g. road-safety, anti-social behaviour, children being abused or kidnapped), and a lack of government support. The cost of healthy (defined as fresh and organic) food and leisure activities were viewed as prohibitively expensive. Retailers and food producers were demonised: parents felt that retailers use tactics to try to enable unhealthy choices; advertising leads to unhealthy choices via pester power; and the positioning of unhealthy food in shops influences food decisions.

Some parents described a sense of futility in the face of these wider societal and cultural pressures. They felt that these influences were a pervasive barrier which reduced the amount of control they felt they had over their children's diet and physical activity, and undermined their efforts to provide a healthy environment in the home.

5.5.2.1.5 Healthy lifestyles fostered in schools

Fostering healthy behaviours was viewed as part of the school's role, achieved through health education, healthy school meals provision, space and equipment for play, structured (and free) opportunities for physical activity through PE and after-school clubs and team-sports. Parents put a lot of faith in schools fulfilling this role; they had confidence that school meals were healthy and relied on schools to provide all the physical activity a child requires to be healthy.

Schools also provided a means of reaching the wider family, via children as 'agents of change'. Children often applied knowledge derived from school to drive healthy behaviours in the home, for example, Change4Life messages, menu planning, and food label reading.

However, school was perceived as less of a positive influence as children get older. The focus on academics over physical activity reduced school and home -based opportunities to be healthy. Discussion around a prioritisation of academic commitments over being physically active arose exclusively in data with South Asian participants (however, since age of children did not form part of the data collection, it is not possible to know whether this pattern is due to the participants having older children or having a genuinely greater focus on academics). Adolescence was also viewed as a phase of increasing independence and responsibility in relation to health behaviours such as diet, and parents felt that school friends were a bad influence.

5.5.2.1.6 Supporting parents: Family, community, government

Parents described a general lack of support from 'upstream' forces such as government and food industry. When parents felt supported by upstream forces, this improved their sense of agency and their perceived 'healthy parenting' abilities. Parents reported using and valuing health care professionals (including Health Visitors and GPs); Sure Start centres; local community-based programmes, such as cooking and gardening clubs; local parks, green gyms and open green space; mobile phone apps (in particular Change4Life); TV cookery and nutrition shows e.g. Jamie Oliver; and government-delivered health messages. A large number of parents had personally attended, or had children who had taken part in, the local council-delivered healthy lifestyles programme OBOL. A small number of parents also talked about places of worship as a space for keeping active and healthy. When parents felt supported, this appeared to lead to healthy behaviour changes.

Parents would like to see community-based programmes extended (long-term or indefinitely); a greater availability of low-cost leisure facilities and activity clubs locally (highlighted by focus groups and interviews in the Moathouse area in particular); a higher frequency of before or after -school clubs; pricing strategies that incentivise healthy food choices and disincentivise unhealthy food choices; and one-to-one home-based support to provide tailored advice within the family setting. Some parents also appeared driven to organise community-led activities, such as family days in the park and church-based exercise classes.

5.5.2.2 Ethnic group specific themes

A summary of themes and example quotes is provided in Table 5.5.

Table 5.5 Ethnic group specific themes and example quotes

Theme	Example quotes
African life vs British life	ID12: "What I've noticed, back at home… there's no Macdonald's or all those sorts of things. There is for people who are richer, but mostly people who are poor they tend to eat what is available in the house, they don't even go to the shops to buy food, but they only eat what is being harvested in the homestead, like in the farms. That's what they normally eat, they don't go buying things from the shop. So there's a big difference here. I think in this country people they can afford food that is expensive, whereas in my… where I come from people they don't afford food that is very expensive, they eat whatever is available in the house, that's what they will eat. So there is no problem of obesity, no." [Interviewer] "And the food that's available at home, that's healthier?" ID12: "It's healthy food because it's from the fields. They do plough in the farms, so everything that is being eaten is organic from the farms." *ID12, mother, Black African, country of birth: Zimbabwe, faith: Christian* ID4: "We try to cook, do what we know for our family. Because you know in this country, too much processed food, it's not good. Everything in a can. Every day vegetables you know, it's not fresh, it's frozen" ID3: "Frozen" ID4: "Frozen vegetables. It good, like vegetables, but it's not really the vegetables, it's not fresh" ID4: "It lose like quality" ID3: "It lose everything" *ID4, mother, Black African, country of birth: Non-UK born, faith: Christian; ID3, mother, Black African, country of birth: Cameroon, faith: Christian* "When I was little in Africa… you have to walk miles to go to school. And then, you wouldn't feel it because it's a way of life. That's how it should be". *ID7, mother, African, country of birth: Nigeria, faith: Christian* "But here all we do is just eat your food, throw your plates in the dishwasher, you sit the TV and you do nothing else." *ID2, mother, Black African, country of birth: Zimbabwe, faith: Christian* "And then the pattern of work in England is quite different to every different country we go. It affects our weight like this. … What gets in the way here is, one is there is no balance between work/life." *ID8, father, Black African, country of birth: Angola, faith: Christian*
The symbolic nature of body size	"It's just with my, where I come from, that's like a cultural thing, so if the child is skinny, 'oh they're not eating well, you're not feeding them well'" *ID1, mother, Black British African, country of birth: Kenya, faith: Christian* "I know our diet is much healthier than my mum's diet, but I think that's because, you know, my mum is elderly so she still has the sort of African culture inbuilt in her and she always believes that people should be fed, you should not be seen to lose weight." *ID2, mother, Black African, country of birth: Zimbabwe, faith: Christian* ID24: "For them to be a healthy child, you need to have these chubby lovely cheeks that you can pinch" [Laughter]

Theme	Example quotes
	ID24: “And you know that’s what grandparents see” ID27: “I think if a child was fat, to them they’d say ‘He’s healthy. He’s healthy’. If a child was…” ID28: “Skinny” ID26: “Skinny, ‘no food’” ID24: “Yeah, they’d say you’re not…” ID27: “Not feeding enough” ID24: “Not feeding, yeah” *ID24, mother, Asian Indian, country of birth: UK, faith: Muslim; ID27 mother, British Muslim, country of birth: UK, faith: Muslim; ID28, mother, Muslim, country of birth: Pakistan, faith: Muslim; ID26, mother, British Muslim, country of birth: Pakistan, faith: Muslim* ID23: “In the Asian culture they say they see a ‘smart’ person they would say that she’s very weak, she needs to put on some weight. And if they see like a healthy person, they would say ‘oh she’s very healthy’. But to me, to us, that won’t be healthy. But to them it’s healthy. Interviewer: So what would that look like to them, what..?” ID23: “To them they say that no, she is strong, and she’s…” Interviewer: “A bigger person?” ID23: “A bigger person, yeah. If they see a bigger person they say no, she’s healthy. And if they see you or me then they’ll say she needs to put on some weight, she doesn’t eat anything. And I do tend to get that quite a lot in my family. They’ll say to my husband don’t you feed your wife.” *ID23, mother, Pakistani, country of birth: UK, faith: Muslim* “Really for your children you want them to be the right weight and the right height. You want them to be slightly like, a bit of fat on them, just baby fat” *ID24, mother, Asian Indian, country of birth: UK, faith: Muslim*
Cultural heritage narrated through food	“Food is like an African tradition so it is not very easy when you have to visit people and have to see other people” *ID2, mother, Black African, country of birth: Zimbabwe, faith: Christian* “…for our food to exist, they have to know it. So that tomorrow they will be cooking it for their children too. So we always tell them [the children] you need to eat that, because I’ve been asked to eat it when I was a child, then we have to ask you, then you will ask your child one day.” *ID8, father, Black African, country of birth: Angola, faith: Christian* “We got our African food, which is healthy food” *ID3, mother, Black African, country of birth: Cameroon, faith: Christian* ID24: “And it’s the, we refer to white chapatti flour, we don’t go looking for brown, or wheat flour, which is much more healthier than the white” ID27: “And like brown rice…” ID24: “Yeah, like who eats brown rice?” ID29: “Who eats brown rice here?” ID24: “No” ID28: “No”

Theme	Example quotes
	ID29: "That's the healthy option. But none of us do" *ID24, mother, Asian Indian, country of birth: UK, faith: Muslim; ID27, mother, British Muslim, country of birth: UK, faith: Muslim; ID29, mother, British Muslim, country of birth: UK, faith: Muslim; ID28, mother, Muslim, country of birth: Pakistan, faith: Muslim*
Gender, physical activity and notions of dignity	ID30: "But there's a taboo about that. You know if Asian women went running, they'd think 'oh my God! Look she's running on the road'. So it's that sort of…. So it's you know, silly things, stereotyping, being judgemental." ID24: "That's why no one does it." ID30: "Yeah that's why I said no one does it. You know, have you ever seen an Asian woman cycling about?" ID24: "I'd love to cycle actually, I'd love to do it!" ID29: "Actually I have! I've seen an Asian girl cycling with her brother in the park" ID24: "Which park?" ID29: "Edgewick park. And I could see the guy, there was men sitting on the benches saying 'hasn't she got no shame, she's sat on…' and that kind of puts you off." ID24: "Of course it does" *ID30, mother, Pakistani, country of birth: UK, faith: Muslim; ID24, mother, Asian Indian, country of birth: UK, faith: Muslim; ID29, mother, British Muslim, country of birth: UK, faith: Muslim* "…from my Asian culture point of view as well, I do feel that when my daughter wants to play outside, I'm a bit 'shall I let her?', I'm really worried about her. Whereas maybe, if it was my son, he does sometimes, will go and play, I'm not that worried about him. I don't know, it's just that… maybe it's just that girl thing that you're more worried about, like their dignity sort of side as well to it." *ID23, mother, Pakistani, country of birth: UK, faith: Muslim*
Transitions in culturally-linked behaviours and beliefs	"But you know, particularly where I come from like, you know, with African culture, they always believe that a chubby baby is a healthy baby. So if you have a skinny baby or tiny baby they always perceive that as not healthy. Even with adults they always believe that the bigger you are it means you've got more wealth and you've got more food. But I think, you know, that that's not necessarily true. And I mean if a child cannot run and play with others and gets out of breath after running a few minutes I think that is an unhealthy weight. I'm not sure." *ID2, mother, Black African, country of birth: Zimbabwe, faith: Christian* "But yeah, I think… I have noticed that the older generation, even they'll say that. They will compare their time when they are looking at you, 'girls, we used to have seven, eight children, and we were still fit and healthy. And you guys, you only had two or three children, and you say you can't have any more'. And they go 'we can see why you can't have any more, because how thin you are'." *ID23, female, Pakistani, country of birth: UK, faith: Muslim* Interviewer: "So what kind of activities would you like to do if you could?" ID24: "Cycling is a good one, I'd love to" ID30: "What go on a bike?" [Laughs] ID30: "Why don't we buy about 50 bikes and all go at the same time!" ID24: "Everyone can stop talking then!" *ID24, mother, Asian Indian, country of birth: UK, faith: Muslim; ID30, mother, Pakistani, country of birth: UK, faith: Muslim*

Theme	Example quotes
	"Sometimes our children don't like our cultural food, so sometimes we go with what they like. Sometimes they like sausage and chips, so we have no choice, we have to do it. But there is a time when we cook the food and we force them to eat it because they were… not force them in a bad way, but force them to eat it because for our food to exist, they have to know it." *ID8, father, Black African, country of birth: Angola, faith: Christian*

5.5.2.2.1 African life vs British life

Parents who had migrated to the UK from African countries drew stark contrasts between life in Africa and life in Britain. The lifestyle in African countries was described as being incidentally or habitually active i.e. more physically demanding household work, more time spent outdoors, further distances travelled on foot and a sociable culture. African parents appeared to have a physically active lifestyle, originating in their own childhoods in Africa, which was made possible by the sense of community around the homes of participants, a culture that supports outdoor lifestyles and a more enabling climate. 'Traditional' African dietary patterns were homemade, and based on fresh and organic fruit and vegetables.

In contrast, British life was perceived as largely sedentary and British dietary patterns were described as processed, low quality convenience foods and takeaways. The idea of 'British food' as unhealthy was evidenced by weight gain upon moving to the UK, and some felt that non-organic food contributes to weight gain.

Many African parents described 'British life' as incompatible with a healthy lifestyle and a contributor to the obesity epidemic. This was down to British priorities that put profits above health, for example building houses on green space (reducing the available safe spaces for children to play); the production of cheap, poor quality, processed food; and work-demands making a work-life balance impossible (impacting upon their ability to be active with their children and spend time making homemade meals).

5.5.2.2.2 The symbolic nature of body size

Mothers from both South Asian and African backgrounds described a cultural valuing of a large body size. Large weight was associated with good health and strength, and was an indication of being well-fed (and consequently, of financial security), whilst low weight was linked to weakness or illness. This was both explicit in the data e.g. *"the bigger you are it means you've got more wealth"* and implicit via reference to status e.g. *"you should not <u>be seen</u> to lose weight"*. Parents from South Asian backgrounds in particular also discussed their parental preference for their own children to not be too slim or underweight. Some parents described differential societal pressures for girls and boys body shapes, and often had to reassure daughters regarding weight. One South Asian participant described a cultural viewpoint that being slim reduces fertility.

The cultural component of these beliefs was evident by parent's use of phrases such as *"where I come from that's like a cultural thing"* and "*with African culture, they always believe"*. The fact that these beliefs often stemmed from, or were reinforced by, elder generations gives some indication of the embeddedness of body size as a cultural symbol.

5.5.2.2.3 Cultural heritage narrated through food

Food practices appeared to be symbolic displays of cultural heritage. The cultural importance of hospitality for African groups, and the role of food in providing hospitality, meant that social visits often resulted in over-eating e.g. *"it's all about the food"*. There was a strong desire to retain traditional dietary patterns, and this was related to parents' nostalgia for home and the symbolic nature of food in heritage-maintenance. The valuing of African foods as nutritionally superior was also apparent.

The sense of cultural belonging that food provided was evident in the terms used when described traditional food practices e.g. *"we"*, *"our"*, *"my"*, versus *"your"*, and the collective cultural importance of food was evident in parents' descriptions of foods in relation to their country of origin, through phrases such as *"back in Africa"*, *"Food is like an African tradition"*, *"our cultural food"*, *"my African food"*, *"my country's food"* contrasted against *"English food"* and *"this country's food"*. The way in which grandparents appeared to be driving these cultural food practices also provides some indication of the embedded nature of these practices.

Maintenance of traditional food practices, even unhealthy ones, seemed important to South Asian parents too, which was evident again by use of phrases such as "*I was brought up with Asian food"* and *"that's how I was brought up",* and by a reluctance to make adaptations to traditional dishes and diets.

Authoritarian disciplinary approaches were also viewed as a cultural practice for African parents, and this approach was exemplified through controlling food behaviours e.g. *"Where we come from, Africa, you tell them, just sit, this is good for you"* and *"where I come from, you eat what you're given".*

5.5.2.2.4 Gender, physical activity and notions of dignity

For South Asian participants, embedded cultural expectations and norms appeared influential upon adult and child physical activity behaviours. Parents talked about taboos relating to the perceived ability of girls and women to be physically active in public. These women felt that they would be judged negatively by the community if they were physically active outdoors, and some extended this perceived judgement to their own daughters. Others felt that it wasn't 'the norm' for South Asian women to exercise publically. These expectations and norms appeared to stem from cultural notions of *dignity*, with use of this term alongside others such as *"shame"*, and in that they were often raised in relation to public displays of exercise and the action of physical exertion.

5.5.2.2.5 Transitions in culturally-linked behaviours and beliefs

Importantly, the cultural expectations, perspectives and norms described were subject to negotiation by parents, which appeared to be the result of decreasing transmission of cultural beliefs in subsequent generations, and/or by a change in context (e.g. migration), in which the cultural belief appeared out-of-touch in the new context.

For example, the cultural valuing of a large body size was considered a traditional view point held by others e.g. grandparents, extended family, whilst parents themselves often did not subscribe to this traditional view point, and were highly aware that excess weight is unhealthy, and generally did not want this for their own children. Parents' use of the term *"they"* and phrases such as *"that kind of old mentality"* showed that this was a view held by others, and parents' negotiation of these traditional beliefs was evident in phrases such as *"no, they are actually fine for their age and their height"* and *"It's not everybody that has been educated about weight".*

In one focus group with mostly South Asian participants of Muslim faith, mothers talked about a desire to challenge the cultural expectations placed upon women doing physical activity (see Table 5.5).

In addition, traditional cultural practices were also renegotiated by children. For example, exposure to British foods in children's day-to-day lives appeared to undermine efforts to retain traditional dietary practices. Some parents from South Asian and African backgrounds felt that their children had a taste preference for British foods, and this sometimes resulted in generational conflict over food.

For African and Caribbean parents who had migrated to the UK, participants felt that differing cultural approaches to discipline hampered parents' ability to control children's health behaviours in the UK context, for example legal restrictions and concerns about child protection.

5.5.2.3 Sociodemographic characteristics underlying beliefs and experiences

A summary of the influence of underlying sociodemographic factors and some example quotes are provided in Table 5.6.

Table 5.6 Socioeconomic demographics and example quotes

Characteristic	Example quotes
Ethnicity	Interviewer: “How about you and your country? Do people so things differently there?” ID11: “Africa, it’s all the same.” *ID11, mother, Gambian, country of birth: Gambia* “Especially I find that with the West Indian families, because brought up, you know, African, West India, the same thing, fresh products. We’re not used to these, what do you call it, artificial erm food, processed food. We’re all fresh food. So everything is grown. Everything is picked from the tree and picked from the ground. *ID14, mother, country of birth: Jamaica, faith: Christian*
Migration	“And I learn as well how to cook, help me honestly for how to manage food from this country because I live here I must know how different life.” *ID6, mother, African, country of birth: Sudan, faith: Muslim* “He [participant’s son] would rather prefer not eating anything with vegetables, or anything from my country. He prefers this country’s food, but without the vegetables. Yeah, it’s vegetables. He says to me my country’s food smells. Yeah. He says, when I start doing it, he goes ‘hmmp, hmmp’.” *ID9, mother, Black African, country of birth: Non-UK born, faith: Christian* “Coming here, yeah, at first at 12 years old, you know, I was like, yes, I can get everything, you know, you have that. Even then, coming from Africa to here and then whatever we were eating I still noticed, it wasn't that much different, it's just there was a lot of it and it was cheap here. …It was, in a way, at 12 years old you're thinking, yeah it's good but you're not conscious then that, you know, actually this might not be healthy for me. That wasn't… because coming from that and then you've come to UK it's a big difference. And then like every week you're going shopping, supermarket, it was like, this is out of this world.” *ID1, mother, Black British African, country of birth: Kenya, faith: Christian* “Because I remember before came here all I said was like, when I get to England I want to eat loads and loads of chocolate and sweets, and I did, that’s probably why I don’t eat them anymore. Here I just overdid on the sugar and everything, I don't do it anymore. Because it's like, I've got a sister who's coming over soon and this is what she talks about all the time, ‘when I get there I want to have so much chocolate and I want to have this and all that’. And she's probably going to do that, like we all did when we got here, but after a time you kind of realise that, oh, I can actually have this every day, so there is no need to like, you know, so then you just leave it, so I have, yeah.” *ID2, mother, Black African, country of birth: Zimbabwe, faith: Christian* Interviewer: “And so how would you say that your lifestyle as a child compares to your children's lifestyle now?” ID1: “Well they do have a better life than me, I won't lie. Sometimes I go shopping, they’re like ‘mum can we get this?’, you want to say to them, like, I never had those privileges, so…” Interviewer: “What kind of things?” ID1: “Like sweets, chocolate, you know, you go in Tesco and they're like there, right there, ‘oh can we get these?’” *ID1, mother, Black British African, country of birth: Kenya, faith: Christian* “Sometimes the weather also doesn’t help, the long winter also. Because I came from very sunny country, I came from Middle East, so I get sick in winter. Which I lose energy. So that is also a problem I think for a foreigner.”

Characteristic	Example quotes
	ID22, mother, Arab British, country of birth: Syria, faith: No religion
Faith	"I think it's hard because here's so much to do. I know laziness is a part, I agree with you sister [in reference to another group member], I know laziness is a part, but it's hard. Because you get them ready for school, and they come to school, and then your housekeeping, cooking the food ready for them to come home, and then they've got the mosque, then they've got their homework, and before you know it, it's time for bed, and that's it, the day's gone." *ID30, mother, Pakistani, country of birth: UK, faith: Muslim* ID12: "On Sunday, that's when you go to church, and in church we participate in lots of activities. Weekends we can go to shopping and do those sorts of things, but every Sunday we go to church then we do participate in activities." Interviewer: "Ah, so do they have… so what do they do at church then to… is it kind of a mass or are there kind of lots of… is it longer and lots of family activities?" ID12: "Yes, it's longer. Children, they've got their own classes that they do, or they encourage them with food that they eat. They also encourage playing, doing all sorts of things and participating in singing, all those simple things for children. It's the adults will sing as well, like we do the decorating, there is a lot of lifting up and then we decorate the church, that is part of physical exercise." *ID12, mother, Black African, country of birth: Zimbabwe, faith: Christian*
Neighbourhood deprivation	"I live in XXX Crescent, and there's quite a few takeaway outlets. So yeah, there can be temptation I think. There's a Dominoes pizza, lots of like, Dixie Chicken, but it's changed to something else now, but still a takeaway. There's another pizza place and an Indian. So it's all there." *ID34, mother, Asian British, country of birth: Kenya, faith: Christian* "You know sometimes you can even think, if like an example, I'm thinking about when they [the children] have time off, like the one week, two weeks and stuff. I'm thinking what am I going to be doing with the children for two weeks, how am I going to entertain them? If you had the money you would probably take them to a beach or a holiday somewhere, for them to run around. And the houses are so crammed together, like very, very tiny houses, not enough room to move about. If I could I would probably install a trampoline right in the middle of my living room. But there is not enough space." *ID9, mother, Black African, country of birth: Non-UK born, faith: Christian*
Socioeconomic position	ID3: "From what I learnt when I was doing courses, I learnt at least you have to eat 5 different fruit at least once a day. But for me it's not that easy." ID4: "Five portion" ID3: "But if you ask me it's not that easy, if you have four children. That's one pound, then that's finished, the next day you get four Mandarin, five Mandarin for one pound. You see what I mean? We can't have that every day. We just try to do our best." *ID3, mother, Black African, country of birth: Cameroon, faith: Christian; ID4, mother, Black African, country of birth: Non-UK born, faith: Christian* "Even when we try and live a healthy life, we don't, I must admit we don't exercise much. Because I work in the evenings and my husband works in the mornings, so he's coming in, I'm going out, so we don't even have the time to take the kids to activities, apart from the after-school club." *ID7, mother, African, country of birth: Nigeria, faith: Christian* "So I think as a single mother your choices become much much less, as a family, where you have partner to help. But if I want to go for a walk or just swimming or gym, I can't. Because I need to arrange for childminder. So it's costly, you understand what I mean? I can't pay for childminder. And I can't go for gym. I can't afford it. So for me, it's not a choice." *ID22, mother, Arab British, country of birth: Syria, faith: No religion*

Characteristic	Example quotes
	"And sometimes there is not enough places for you to go, even with the children, especially in Coventry here. And if you don't have the means of driving and taking the bus, and even sometimes, thinking about if you're going some places it's so expensive, and you think, I don't want to go, why don't I just stay at home instead of paying for such an expensive thing." *ID9, mother, Black African, country of birth: Non-UK born, faith: Christian* "Because we not have car, we not have anything, we have to walk" *ID11, mother, Gambian, country of birth: Gambia*

5.5.2.3.1 Ethnicity, migration and faith

Ethnicity

There was a clear presence of 'ethnicity' in the data, with parents making reference to their ethnicity, ancestry or country of origin in relation to cultural influences upon health. For example, *"we have this African thing"* and *"coming from an Asian family"*.

Interestingly, participants from African countries tended to self-define their ethnicity as 'African' rather than on the basis of their nationality. The data also suggested that participants appeared to identify more with collective 'African' culture / being 'African' than that of their specific native countries/states, although this may be the result of an interviewer effect. Caribbean participants felt that their African ancestry influenced their cultural perspectives.

Despite most participants with African or Caribbean backgrounds describing themselves as 'Black African' (or similar), 'race' rarely arose in the interviews and focus groups, with the exception of focus group number three, where this was generally used in reference to describing isolation *"we were the only Black family at the time in the village"*.

Migration

Migration was a period of practical and cultural transition for African and Caribbean groups, and there was evidence of 'acculturation' towards beliefs and behaviours of the British population. For example, there was a move towards British dietary practices as a result of difficulty in finding traditional African foods in local shops, and the high expense of organic foods, and child preferences for British foods. One parent who felt that it was important for her children to adapt their traditional dietary patterns in order to better integrate upon migration to UK.

A small number of parents from African backgrounds described how the experience of migrating from an environment of relative hardship and scarcity to one of perceived comfort and abundance had resulted in unhealthy behaviours (for example, over-indulging on sweets and chocolates upon arrival in the UK). There was some indication that calorific foods were given special status, through use of the term *"treat"* throughout parents' descriptions, and phrases such as *"in Africa you only tend to get chocolate on your birthday"*. These participants described a period of adaptation in order to realign their ways of thinking with this new environment.

Transitions in the cultural valuing of a large body size also appeared influenced by acculturation towards British societal values. In the South Asian group, two mothers discussing cultural valuing of a large body size also mentioned girls' self-consciousness about weight, which appeared to stem from societal pressure relating to a focus on female appearance.

The influence of bad weather upon physical activity was also a dominant theme for parents who had migrated to the UK from overseas (discussed by 14 of 21 parents born overseas; and 2 of 12 born in the UK), and parents found it difficult to acclimatise which restricted their motivation to spend time being physically active outdoors.

Faith

Some influences also appeared related to faith, for example, commitment to attend mosque as barrier to health and a traditional cultural valuing of large weight status appeared more often in the data of Muslim participants in the South Asian group. Social norms around female exercise were found in parents from Muslim backgrounds only, regardless of ethnicity.

African participants of Christian faith also appeared to value the church as a 'community centre', and linked church attendance to improved physical and mental health.

5.5.2.3.2 Neighbourhood deprivation and socioeconomic position

Factors relating to neighbourhood deprivation and socioeconomic position arose naturally in the conversation fairly consistently across all participants, and formed the basis for many of the contextual influences upon parents' health behaviours.

Neighbourhood deprivation

Neighbourhood deprivation arose in parents' descriptions of neighbourhood safety concerns, particularly in relation to crime and anti-social behaviour, restricting physical activity. Contrasting experiences also existed regarding access to open space, based on parent's IMD. Two participants from areas of low deprivation talked of living nearby open green space, facilitating outdoor activity.

Socioeconomic position

Socioeconomic position influenced parental workloads (e.g. working long hours, shift work), placing limits on family dietary and physical activity behaviours. Contrasting experiences also existed regarding car use, based on parent's IMD. Some participants from areas of high deprivation did not have use of a car, which facilitated walking as a dominant form of exercise but acted as a barrier to transporting children to structured activities elsewhere in the city.

5.6 Discussion

This research aimed to gain parents' perspectives of the cultural and contextual factors that influence childhood overweight status for ethnic groups at high risk for obesity in Coventry. Both universal and ethnic-group specific themes were found relating to parents' experiences, perspectives and beliefs around health, diet, physical activity and weight, which appeared to influence families' health behaviours. Within the data, key barriers and facilitators to achieving a healthy weight were identified alongside parents' views on how to support local families to achieve a healthy weight.

5.6.1 Comparison to other research

5.6.1.1 Universal findings

Many of the barriers and facilitators to keeping healthy found in the current study have been identified elsewhere in the literature. These include time scarcity, low affordability of healthy food, and the negative role of media and marketing upon dietary choices (Hesketh *et al.*, 2017; Jabs *et al.*, 2007; Mills *et al.*, 2017; Parks *et al.*, 2016; Pocock *et al.*, 2010). Low availability and high cost of local leisure facilities, unsafe and unattractive playgrounds, a lack of open space and poor weather have been also been identified elsewhere by parents as key barriers to children's use of the local environment for physical activity (Eyre, 2014; Eyre *et al.*, 2015b; Hesketh *et al.*, 2017; Pocock *et al.*, 2010; Rawlins *et al.*, 2013; Trigwell *et al.*, 2015; Veitch *et al.*, 2006). As in the current study parental restrictions were dominated by concerns about neighbourhood safety in particular (road/traffic e.g. speeding, stopping at lights; crime e.g. attacks; abduction; and anti-social behavior e.g. alcohol and drugs, intimidation) (Department of Health, 2008; Eyre *et al.*, 2014; Trigwell *et al.*, 2015; Veitch *et al.*, 2006).

In terms of facilitators, school has been consistently viewed by parents, stakeholders, researchers and policy-makers as important in promoting healthy behaviours, role modelling and in meeting physical activity guidelines (Clarke *et al.*, 2013; Clarke *et al.*, 2015; Department of Health, 2008; Eyre *et al.*, 2015a; Khambalia *et al.*, 2012; Langford *et al.*, 2015; Pocock *et al.*, 2010; Trigwell *et al.*, 2015; Waters *et al.*, 2011). Other researchers have also identified the valued role of family-based mealtimes and activities (Fulkerson *et al.*, 2008; Malhotra *et al.*, 2013; Thompson *et al.*, 2010).

5.6.1.2 Ethnic group specific findings

The existing research also highlights some of the same distinct perspectives of weight, diet and physical activity related to ethnicity identified in the current study, which influenced health behaviours both positively e.g. eating together as a family, and negatively e.g. assimilation to 'host country' diets; a reluctance or difficulty in adapting traditional food practices, and the key role of food in the social lives of South Asian and African ethnic groups (Bush *et al.*, 1998; Department of Health, 2008; Lawton *et al.*, 2008; Ludwig *et al.*, 2011; Ochieng, 2013; Osei-Kwasi *et al.*, 2016; Rawlins *et al.*, 2013; Trigwell, 2011). Prioritisation of educational attainment over physical activity was also observed in parents from Asian Bangladeshi (as well as Chinese and Yemeni) ethnic groups in one qualitative study (Trigwell *et al.*, 2015). This educational aspiration may be related to a desire for social mobility, or underpinned by Islamic values (Crozier, 2009).

African parents in this study and elsewhere describe low access and affordability of foods required to retain their healthy traditional diets (Osei-Kwasi *et al.*, 2016). Grandparents have been reported as a negative influence on the dietary behaviours of children from Bangladeshi and Pakistani backgrounds (Department of Health, 2008), a factor that both South Asian and African participants described in the current study, alongside a reluctance to criticize the behaviours of grandparents.

A commonly proposed explanation for cultural valuing of large body size, observed in African and UK South Asian groups (Greenhalgh *et al.*, 1998; Lucas *et al.*, 2013), (Amenyah & Michels, 2016; Department of Health, 2008; Nicolaou *et al.*, 2012; Puoane *et al.*, 2005; Rguibi & Belahsen, 2006; Toselli *et al.*, 2016; Tovée *et al.*, 2006; Trigwell *et al.*, 2014) is that in places where food availability is low, a larger body size may be symbolic of affluence and health, and preferable for survival and reproduction (Kumanyika, 2008; Lucas *et al.*, 2013; Mvo, 1999; Tovée *et al.*, 2006;

Wells, 2009). The current findings support this symbolic basis of body size ideals.

Cultural expectations around physical activity in females has been reported in other literature for both adults and children, which become more apparent as girls transition to adolescence and young adulthood (Bhatnagar *et al.*, 2016; Koshoedo *et al.*, 2015; Lawton *et al.*, 2006; Miles & Benn, 2016). In the current study, due to low visibility of South Asian women engaging in physical activity in public spaces as a result of these cultural expectations, there was a sense that physical inactivity was the social norm. This was also found to be the case in a meta-ethnographic review of 14 qualitative studies, in which South Asian groups perceived physical activity to be absent from their culture (Koshoedo *et al.*, 2015). As noted in the current study, Bhatnagar *et al.* (2016) also found some resistance to the established cultural norms around females exercising, suggesting a generational shift in attitudes over time, which was even more apparent in studies with young Muslim women and girls (Knez *et al.*, 2012; Miles & Benn, 2016; Stride, 2014; Stride, 2016).

The current research identified the potential role of church in enabling physical activity for some African and Caribbean participants, e.g. through singing, dancing and participation in church life such as decorating. This contrasts with findings by Department of Health (2008) in which commitment to attending church was viewed as a barrier to PA.

5.6.2 Contribution to existing research

Through synthesis of a rich qualitative data set, this research has identified some new insights regarding both universal and ethnic group specific influences.

5.6.2.1 "It was a healthy way of living"

There was a thread linking a number of universal themes identified in the current study: nostalgia for parent's own childhoods, parents' conceptualisations of health, the struggle to achieve the 'healthy family ideal', and the overwhelming influence of modern life.

A healthy lifestyle fitted in with parents' conceptualisations of what family life should look like, with family mealtimes and family-based activity highly valued by parents. The current findings suggest that the idealised version of 'the healthy family' appeared to be attached to parents' nostalgia for their own childhoods, which formed the basis for their conceptualisations of health (freedom, outdoor play, family meals).

However, modern society was viewed as unsupportive of the healthy family ideal and created a sense of a lack of control over one's ability to provide a healthy lifestyle for the family. Parents' realities were at odds with their idealised image, in which this desired lifestyle was overridden by the more immediate need for convenience and minimal conflict, with this need generally driven by busy and stressful lives.

As in the current study, another qualitative study with parents in Bristol found the notion of being physically active as a full family unit to be a 'mythical ideal' (Thompson *et al.*, 2010), and the current study suggests this mythical ideal applies to family mealtimes, in addition to physical activity. The current findings go further to link the mythical family ideal to parents' nostalgia for the past, which appeared to 'set the bar' for expectations of family life, despite the extreme contrasts in contexts (e.g. society, the environment) described by parents between their own childhoods and their children's childhoods.

5.6.2.2 "Where I come from…"

Participants from African backgrounds cited similar barriers to physical activity a healthy diet to participants from other ethnic groups in the current study, but the main difference was that many of these barriers were highlighted as uniquely 'British' problems, that were absent in their native environments, including: concerns about safety of unsupervised play (many attributed this to a lack of a sense of community); a poor work-life balance (driven by British values that prioritise productivity over the family); the role of technology and convenience in the home (household chores are less labour-intensive and food is purchased rather than grown); and climate (weather and darkness restrict outdoor activity). Each of these barriers has been highlighted in previous research with minority ethnic groups (Koshoedo *et al*., 2015; Long *et al*., 2009; Persson *et al*., 2014), although the qualitative nature of the current study highlights how parents view these as a 'British way of life'. Research with Somali mothers who had migrated to Sweden found a similar dichotomisation between 'life in Somalia' and 'life in Sweden' dictating physical activity habits (Persson *et al*., 2014). Interestingly, many of the African participants in the current study reported living in other European countries e.g. Spain, the Netherlands; yet considered the structural, cultural and environmental barriers to healthy living as uniquely British.

5.6.2.3 Managing and renegotiating traditional cultural behaviours and beliefs

5.6.2.3.1 "For our food to exist, they have to know it"

The current study identified a strong desire to retain traditional dietary practices, which arose out of parents' conceptualisations of 'African' food versus 'British' food. Parents attached high status to traditional foods, for both nutritional value and for posterity. However, this strong desire to retain traditional practices contrasted with children's preferences, creating conflict. This conflict meant that migrant parents were under pressure to adopt 'flexible' food practices despite holding strong desires for 'continuity' of traditional food practices (Osei-Kwasi *et al.*, 2017), and this seemed to be driving a move away from healthy traditional dietary patterns. Although dietary acculturation in younger and subsequent generations of migrants, and its related generational conflict, has been observed in other studies (Gilbert & Khokhar, 2008; Uskul & Platt, 2014), the current qualitative exploration suggests that, coupled with changes in social norms around disciplining children, and the stressful lives that parents report, this conflict may provide added pressure upon parents from migrant backgrounds to concede to their children's unhealthy dietary desires.

5.6.2.3.2 "That kind of old mentality"

It was also noteworthy that although African and South Asian parents in this study described a cultural preference for a large body size, this was seen as a traditional or ancestral view, which modern parents did not fully subscribe to. This suggests a cultural shift in body size beliefs, driven either by low generational transmission of beliefs, or by migration to a country in which a large body size is associated with poverty. This has been attributed to adaptive behaviour driven by social learning, and mediated by social interactions and the media environment (Tovée *et al.*, 2006). Although other studies have identified transitions in the body size preferences of African people following migration, or for UK-born African adults (Toselli *et al.*, 2016; Tovée *et al.*, 2006), this has typically been described in relation to adult populations and with reference to attractiveness. The current study suggests these transitions in body size preferences also apply to parent's views about children's weight, and is driven by increased knowledge and awareness about the long-term health effects of obesity.

5.6.3 Strengths and limitations

The methodological strengths and limitations are discussed below, alongside a reflexive summary of how my positionality as a researcher may have influenced this research.

5.6.3.1 Key strengths

The key strengths of this study are the use of purposive sampling; recruitment methods; the use of focus groups; and the ability for participants to self-define their own ethnicity via a free text box.

The use of purposive sampling allowed for focused recruitment of those from groups at high risk for childhood obesity, which was more achievable than aiming to explore the views of parents from all of the key ethnic groups. A period of relationship-building was first undertaken with community groups, faith and school leaders in order to overcome any potential 'gatekeeper' effect in access to potential participants (Clark, 2011). However, not all attempts to build relationships with community groups, faith centres and schools was successful, limiting wider recruitment of a larger number of participants. Recruitment also included contacting parents who had attended the local weight management programme OBOL, to ensure the views of parents with overweight children were gathered. In reality however, very few participants were recruited via this channel due to low response rates, possibly due to the burden related to use of postal response.

The use of focus groups can be considered a strength in the current study. Focus groups are credited with a greater ability to support the construction of shared understandings and cultural norms compared to other qualitative methods, providing a rich understanding of the social worlds of participants (Silverman, 2014), hence are particularly useful in research with ethnic minority groups (Kitzinger, 1995). Through the use of focus groups, participants can also provide mutual support for experiences that deviate from mainstream culture, thus overcome the potential for research with ethnic minority groups to conform to that of the majority population (Kitzinger, 1995).

Allowing participants to self-define their own ethnicity is unusual within research, yet was considered important given the nature of ethnicity as a multi-dimensional construct which is not fully captured through categorisation (Bhopal, 2014). McKenzie and Crowcroft (1996) recommend collecting as much information as possible about the ethnicity of research participants and describing ethnicity on this basis, rather than using limited existing taxonomies such as census classifications, whilst other researchers (Burton *et al.*, 2010; Senior & Bhopal, 1994) suggest using classifications of ethnicity that suit the purpose of the research, including multi-dimensional measures or triangulated methods. This study opted for a triangulated approach in which both census categories and self-description via a free text box was offered (at different time points, using different forms). However, in reality, a number of participants left the free-text box blank, which meant relying upon census-defined categories for some participants, and self-defined ethnicity for others. Despite the option to describe their ethnicity in their own words, most opted for traditional categories such as 'Black African', and it was also apparent that participants consulted one another in response to this question. It may be that participants were uncertain when asked to self-define their ethnicity, being accustomed to 'tick-box' options, and perhaps needed more time to consider their responses more thoughtfully. The use of two ethnicity data collection tools also added complexity and inconsistency when describing the sample and when using participants' quotes.

The offering of both focus groups and one-to-one interviews allowed for greater recruitment and participation of those who felt uncomfortable in a group setting, so has allowed for a broader range of views to be collected.

5.6.3.2 Key limitations

Key limitations include validity issues related to sampling and recruitment, data collection methods, and the generalisability of findings.

Firstly, there was an absence of participants from Bangladeshi backgrounds and a low number of parents from Caribbean backgrounds (this group consisting largely of grandparents). In addition, despite attempts to use purposive sampling, in reality, working with existing established community groups with a broad client base; recruitment via community gatekeepers; and a need for a minimum number of participants for focus group viability meant that opportunistic sampling was often employed, and ethnically homogenous focus groups were not always possible in practice. The overall response rate was low, and it may be the case that participating individuals were those with an interest in health and well-being, which may have influenced the findings i.e. participants in the current study may have been generally motivated to be healthy.

In the current study, all participants from African backgrounds were born outside of the UK and the majority were Christian, whilst those from South Asian backgrounds were both UK-born and born overseas, and the majority were from Muslim backgrounds. The sample make-up is a result of targeted recruitment methods, for example, African families were approached via churches (alongside other channels). It was therefore not possible to explore within-group heterogeneity in perspectives and experiences (e.g. interactions between ethnicity, faith, language and migratory history). The sample also limits the generalisations that can be drawn from this research. However, researchers question whether generalisation to the wider population is really possible in qualitative research given its context-specific, culturally-situated nature (Schwandt, 1997; Tracy, 2010). As stated by Silverman (2014), generalisation in qualitative research is about recurrent social processes rather than sampling individuals, and so a more appropriate aim would be for transferability (theoretical and practical) and resonance of the social processes to other contexts and populations (O'Reilly & Kiyimba, 2015; Tracy, 2010).

The research findings are also skewed towards the experiences of mothers, due to low recruitment of fathers, a common issue in research on childhood obesity (Davison *et al.*, 2016). This may have been due to greater availability of mothers due to unemployment or part-time working for example, however, interviews and focus groups were offered and delivered in the evenings and on weekends to attempt to overcome this. Another potential explanation is that gatekeepers preferentially recruited mothers over fathers, or that mothers more readily identified with the nature of the research as 'family research'. Researchers have highlighted the cultural and social positioning of women as the primary carers of children, and hence the main bearers of responsibility for family care and health, particularly food provision and nutritional regulation, regardless of employment outside the home (Kushner, 2005; Kushner, 2007; Madden & Chamberlain, 2010; Maher *et al.*, 2013; McCarthy & Edwards, 2011). Purposive sampling based on parental gender may have enabled greater exploration of the differing roles of mothers and fathers upon obesity-related behaviours in children (Lloyd *et al.*, 2014).

There were few participants from areas of low deprivation, limiting opportunities for comparison across deprivation gradients. The lack of language translation / interpretation services also restricted the extent to which the study adequately captured the views of those with limited English, which may have excluded relatively new migrants for example, or those with low levels of integration into British culture, two potential important aspects to explore. The influence of parental weight status upon perspectives and beliefs was also not clear. Although weight status data were collected, this was self-report and a large proportion of participants chose not to answer this question, so it was not considered during the analysis phase.

Theoretical sampling based on themes arising may have been a useful technique in achieving greater data saturation. For example, a code indicating that mothers believe they have a larger role than fathers in children's health arose during data analysis. However, this was not explored in further detail in thematic analysis as the low recruitment of fathers prevented the comparing and contrasting of the perspectives of fathers versus mothers. Theoretical sampling on the basis of gender would have enabled greater exploration of this potential theme.

There are limitations to my use of focus groups as my key mode of data collection, for example, ensuring that all voices were heard and the potential for assent to group norms, which may ignore the experiences of individuals that differ from the norm (Kitzinger, 1995). Another issue regarding data collection is that focus groups did not always meet the ideal number, reducing the effectiveness of this format in generating lively, co-constructed data (when numbers were too low) and leading to over-dominance of a small number of participants (when numbers were too high). Some participants also left part-way through for various reasons such as childcare, interrupting group processes and reducing the richness of data obtained in some focus groups.

5.6.3.3 Reflexive summary

The findings presented are based on my interpretations and should be considered within the context of my epistemological stance and my personal characteristics as a researcher (Lincoln & Guba, 1985; O'Reilly & Kiyimba, 2015).

5.6.3.3.1 Positionality

For example, the sample was a multi-ethnic group living in deprived areas of Coventry. With an ethnic background self-defined as a White British and Irish, and having little experience of living in a deprived area, I had concerns that my differing social background may have limited rapport-building and my ability to access cultural perspectives that were strongly embedded in participants. In reality, I found participants enthusiastic to share their descriptions and experiences, and it appeared as though participants felt the need to provide depth when explaining their values, cultures and traditions, which may have strengthened the richness of the data (Barbour, 2007). Rhodes (1994) proposes that addressing imbalances in power is a more valuable aim in research than aiming for researcher-participant matching, a task which can be achieved through sensitivity to this imbalance. I believe my curious and empathetic approach provided such sensitivity despite the differences in ethnic and social backgrounds.

On the other hand, participants may have been selective about what they shared (Adamson & Donovan, 2002), and it is debated the extent to which researchers can truly access the perspectives and experiences of their participants (Hammersley, 2007), particularly when the researcher's ethnicity differs from that of the participants (Ochieng, 2010). For example, descriptions of experiences of racism or discrimination and explicit mention of the role of ethnicity or skin-colour in general are present in other research findings on health, obesity and physical activity (Long *et al.*, 2009; Ochieng, 2013), but were absent from this data. A similar phenomenon was also noted by Rhodes (1994), in which 'race'-interviewer effects were most noticeable in categories with explicit 'race' content, as well as those with social desirability implications, another important consideration in research on health.

The following exchange (Figure 5.4) within a focus group with South Asian participants provides an example of when my differing ethnicity and perhaps a lack of cultural competency interfered with my understanding of a participant's description of a South Asian food item and emphasised my 'outsider' status (Dwyer & Buckle, 2009). Despite an additional prompt from me to obtain more information, I felt as though I did not fully grasp the participant's meaning:

Figure 5.4 Example of an exchange from South Asian focus group

Interviewer: “And so thinking about your own family and your own food and diet, how healthy do you think it is?”
ID29: “Not healthy”
ID27: “Not healthy”
ID29: “To tell you the truth, it’s not healthy”
ID27: “No, it’s not”
Interviewer: “So what do you think makes it unhealthy?”
ID27: “The curry that we eat” [laughs]
ID24: “So much oil and butter”
ID27: “Butter and oil, chillis, (ghararo)” ((Researcher note: final word was spoken in another language, sounded like ‘ghararo’))
Interviewer: “What was that?”
[Laughter from group]
ID27: “More spicy, like it a bit more spicy!”

As I relied heavily on recruitment via community gatekeepers, my positionality may also have contributed to the population I was given access to via a ‘gatekeeper effect’ (Sanghera & Thapar-Björkert, 2008). However, I met with gatekeepers on several occasions to discuss the nature and objectives of the research, and for the most part I approached potential participants personally through a high presence within community centres, giving me some control over those invited to participate. However, my ethnicity may have impacted upon the decisions of potential participants to take part in the study. These two factors (gatekeeper effect and positionality) may have contributed to the low response rate achieved.

Additional positional influences in my role as researcher were my gender (female) and my own weight status (healthy weight). Other researchers have discussed the challenges of researching obesity as a ‘healthy weight’ researcher (Throsby & Evans, 2013), and for the current research this may have led to a reluctance of obese parents to participate or may have restricted parents discussions of their own experiences of obesity for fear of being judged, particularly given the anti-fat prejudices that dominate in society, the media, and health services (Budd *et al.*, 2011; Hilbert & Ried, 2009; Schwartz *et al.*, 2003; Throsby & Evans, 2013). This also applies to mothers’ discussions of their children’s weight status, since mothers of overweight children also report feeling judged (Tanner *et al.*, 2013).

Although I did not target mothers in recruitment, as a female researcher, fathers might have assumed I was more interested in a mother's viewpoint, which may have limited their participation. Within interviews and focus groups, mothers were sometimes critical of fathers (which may not have arisen if the researcher were male), and contrastingly, some gendered experiences may have been left unsaid, as female participants may have assumed I had knowledge of the 'female' experience.

Acknowledging the potential ethnocentricity of the research is an additional consideration in research across ethnic groups (Bhopal, 2014). This ethnocentricity may lead researchers to fixate on, and probe about ethnic-specific experiences. Upon reviewing the transcripts however, ethnic group-specific experiences were more often discussed spontaneously by parents than probed for by me, and ethnicity (and its related variables) appeared to be dominant in the experiences of those from African backgrounds in particular, likely because these participants were all first-generation migrants. Ethnocentricity may also have contributed to my decision to construct the findings in relation to 'universal factors' and 'ethnic group specific factors'. This may potentially give undue weight to the presence of differences across groups. However, the discussion has highlighted that there were more similarities than differences in the data, with many shared universal experiences.

5.6.3.3.2 Mode of data collection

My facilitation of focus groups may have also influenced the data generated. Barbour (2007) emphasises how group dynamics and personalities can influence the interactions between participants, and consequently the data generated. As a relatively inexperienced researcher, it is possible that I missed opportunities to encourage participants to share experiences and to ensure the engagement of all participants. This was particularly the case in one large focus group with nine participants, in which it was difficult to manage the dominance of a small number of participants. This may have led to the absence of data reflecting the experiences of less confident participants, including those with English as a second language for example.

In addition, my use of both focus groups and interviews may have been an issue, as the data from both modes of data collection may not be directly comparable. For example, in one focus group (group 5), two participants with English as a second language did not contribute substantially to the conversation and when prompted, deferred to the opinions of others within the group. This missed the opportunity to gather these participants' experiences and perspectives in their own words, which may have been more easily achieved in a one-to-one interview, in which there would have been more time to for these participants to contribute their thoughts.

On the other hand, the focus group setting may have enabled a more comfortable environment for sharing collective experiences of a sensitive nature, such as experiences of racism (see section 5.6.3.3.1).

However, there were no codes or themes that arose exclusively in either interviews or focus groups only. In addition, the use of both methods allowed for greater recruitment and participation of those who felt uncomfortable in a group setting, so allowed for a broader range of views to be collected.

5.6.4 Implications for service and intervention design

This research has provided valuable insights into what motivates parents' health behaviours, which can feed into intervention design, including messaging, targets and settings. In addition, this research adds to the literature on the socio-cultural factors that shape people's perspectives and behaviours, considered as essential for effective communication between health services and the communities they serve (Bhopal, 2014).

5.6.4.1 Child and family-based interventions

The findings from the current qualitative study suggest that parents would value interventions targeted as increasing the frequency of family mealtimes in the home and opportunities for family-based physical activities, since parents were highly motivated towards a 'healthy family ideal', and evidence suggests effectiveness (Brophy-Herb *et al.*, 2017; Fulkerson *et al.*, 2014; Garcia-Cervantes *et al.*, 2016; Rogers *et al.*, 2017; Utter & Denny, 2016). The qualitative data suggest that parents would be receptive to interventions that aimed to improve their preparation of healthy, quick, easy and low cost home-cooked meals for the family. Parents may also value interventions that aim to decrease sedentary behaviours and increase physical activity *within the home*, although these may face resistance due to parents' conceptualisations of the home as a sedentary space. Changing parental perceptions of the home as a sedentary space should therefore be incorporated to the aims of health messaging.

This study also suggests that interventions aimed at children e.g. within a school setting, could be influential not only in improving the health of the individual child, but also that of parents and siblings too. Likewise, in their qualitative evaluation of a schools-based obesity prevention programme in Birmingham, Clarke *et al.* (2015) found that children affected change at home as a result of the programme (e.g. through encouraging parents to change their dietary habits), and parents welcomed this role reversal. Centring the intervention around the child as the agent of change within the home has been used effectively in improving salt intakes, weight loss, physical activity and cardiovascular risk outcomes in parents in randomised controlled trials (Gunawardena *et al.*, 2016; He *et al.*, 2015; Luciana *et al.*, 2012).

5.6.4.2 Neighbourhood and community

Interventions to improve outdoor, neighbourhood provision of physical activity are a priority for increasing families' opportunities to be physically active, with parents citing this a key barrier. This seems to be a particular issue in Coventry, in which a report by Coventry City Council (2008) found the city to be deficient in parks, open space and children's fixed play provision, and found the multi-use games areas to be of generally poor quality (rating based on factors such as vandalism and surface quality), particularly in the north east (where many of the focus groups and interviews were held). Opening school playgrounds and providing attendants outside of school hours (Farley *et al.*, 2007), adapting the environment to provide 'court' style settings in residential areas (e.g. cul-de-sacs) (Veitch *et al.*, 2006; Veitch *et al.*, 2010), and regularly closing streets to though-traffic (Gill, 2016; Play England, 2016) may be particularly impactful for the current study population. Interventions need to consider how cold, hot and wet weather and fewer day light hours contribute to seasonal variation in physical activity. Potential solutions include providing ideas for ways to be active indoors in wet weather and providing open and well-lit outdoor facilities for play in the winter months. Building resilience and habitualising children to poor UK weather conditions is also recommended as an intervention component.

Interventions that aim to improve the nutritional contribution of takeaway food to children's diet would be beneficial, and this includes upstream approaches lead by local authorities or government e.g. providing guidance to food outlets on providing healthier choices to customers; and planning policies to control the over-concentration and proliferation of hot food takeaways locally, particularly around schools or in areas with existing high provision (Public Health England, 2017a).

The extent to which such policies are effective in reducing child obesity levels is yet to be proven, and there are few good quality studies that evaluate the impact of such interventions, particularly upon food consumption (Hillier-Brown *et al.*, 2017). However, interventions focused on restricting choice and incentivisation appear to show promise (Hillier-Brown *et al.*, 2017).

The current findings also suggest that parents would be receptive to support from local government, such as local family-based interventions. Many parents were already engaged in the local obesity prevention intervention OBOL, and anecdotally reported improved obesity-related behaviours. Together with the programme evaluation, which found the programme to be effective in improving children's diets and physical activity levels, and in reducing BMI in overweight or obese children (Towey *et al.*, 2011), this provides support for the continuation of the OBOL approach. It is worth considering however, that the high awareness and positive reports of the local offer may be a result of respondent bias, in which motivated parents were more likely to both partake in such programmes and volunteer for this research study. Nevertheless, parents appeared to trust the OBOL service and were enthusiastic for continued support and an expanded offer, with suggestions including family fun days and in-home cooking support.

5.6.4.3 Upstream approaches

Parents saw a key role of both national and local government in supporting families to be healthy, believing that this support would improve their sense of agency and their perceived 'healthy parenting' abilities. This includes pricing strategies e.g. food taxes or subsidies, control over the advertisement of unhealthy foods to children, and government-delivered healthy eating messages and campaigns. Parents also valued TV cookery shows and celebrity chefs, so health messages delivered through these channels show promise. The current study suggests that parents would be receptive to reframing the role of digital devices as health enablers rather than barriers to health, through mHealth, eHealth and social marketing approaches.

5.6.4.4 Culturally-tailored approaches

There are also a number of implications that could feed into the targeting of messaging or intervention components for those from specific ethnic groups. Interventions targeting those from minority ethnic groups should aim to capitalise on existing beliefs and attitudes that contribute positively to health behaviours rather than only focusing on those that contribute to unhealthy behaviours.

Key recommendations emerging from the current study include: 1) supporting parents who have recently migrated to the UK in retaining healthy practices (utilising existing assets of the community) and beliefs through individual or group-based health counselling, to address the newly-apparent barriers to diet and physical activity for these families upon their move to the UK; and 2) addressing structural and cultural constraints to Muslim females participating in physical activity and considering the use of role modelling to help shift cultural norms.

Recommendations for culturally-tailored childhood obesity services and interventions are explored in more detail in Chapter 7.

5.6.5 Remaining gaps in the literature

This research has enabled a better understanding of the cultural and contextual basis of the determinants of obesity in Coventry. By specifically aiming to understand universal and ethnic group-specific influences upon obesity-related behaviours, the study addresses the gap identified by Osei-Kwasi *et al.* (2016), and in particular included an exploration of dietary behaviours in migrants from Sub-Saharan Africa, currently missing from the literature.

However, a number of gaps remain within the research. Future qualitative research should aim to 1) recruit Bangladeshi and Caribbean parents; 2) incorporate generation/migration status and faith into the sampling frame to consider how these interact with ethnicity; 3) incorporate parent and child weight status categories (collected using objective measures) into the sampling frame to better understand how views differ across overweight and healthy weight groups; 4) understand the role of parental gender upon childhood obesity behaviours, in particular its intersection with ethnicity; 5) consider a comparative approach to exploring the role of area deprivation or SEP. In terms of methods, use of constructionist analysis for focus groups, or naturalistic methods such as ethnography, may provide opportunities for greater depth in understanding the experiences and perspectives of those from minority ethnic groups. Finally, these findings should be tested within conceptual models of childhood obesity to determine their cross-cultural applicability (Ludwig *et al.*, 2011; Osei-Kwasi *et al.*, 2016).

5.7 Conclusions

Exploration of parental perspectives, beliefs and experiences has revealed strong motivations for healthy dietary and physical activity behaviours that are more often than not obstructed by the demands of family life, parents' conceptions of what it means to be healthy versus every-day reality, and over-bearing environmental and macro-level influences that give parents a low sense of agency and control. On the other hand, a number of opportunities for enhancing the health behaviours of families were identified, including the key role of the child as an active agent, re-framing the home as a physically-active environment, and making use of technology for promoting rather than inhibiting healthy behaviours. Parental beliefs and experiences were underpinned by their experiences of living in an area of deprivation, their socioeconomic position and by their ethnicity, faith and migratory history, which influence family health behaviours both positively and negatively.

Future research recommendations are made, such as incorporating the views of a wider number of ethnic groups and better taking into account how interactions between country of origin, faith, migratory history, gender and socioeconomic status may diversify parental beliefs and experiences further.

The findings are helpful in informing the design of relevant health messages and services for tackling childhood obesity in ethnically diverse UK populations.

5.8 Chapter summary

This study has filled some of the gaps identified in study component 1 (systematic review) and study component 2 (analysis of quantitative data) by using qualitative methods to explore the potential cultural and contextual basis of ethnic inequalities in childhood obesity in Coventry. To provide greater focus, ethnic groups at high risk for overweight and obesity were purposively sampled based on the findings from study component 2. The findings from this study are next interpreted alongside those from other study components through a mixed methods analytical integration. Finally, in Chapter 7, I consider the ways in which the findings from this study component, alongside those in other study components, align with existing conceptual models that attempt to explain childhood obesity and consider the cross-cultural applicability of these models.

Chapter 6 Mixed methods analytical integration

6.1 Chapter outline

As a mixed methods study, this chapter brings together the findings from across all four study components in order to integrate and summarise findings in a meaningful way. This chapter begins by outlining the need for mixed methods analytical integration, describes the analytical approach developed specifically for the purposes of this analysis, and presents the findings. The discussion describes the ways in which the study components add value and cohere with one another, seeks further explanation from the existing literature and acknowledges the strengths and limitations of the analytical approach.

6.2 Background

A number of studies utilising mixed methods designs have sought to explore aspects of childhood obesity in primary school aged children (Berge *et al.*, 2017; Bilinski *et al.*, 2010; Davison *et al.*, 2013; Li, 2013; Olds *et al.*, 2013; Preston, 2014; Shaltout, 2014; Solomon-Moore *et al.*, 2018), with some specifically aiming to understand the role of ethnicity upon obesity (Alexander *et al.*, 2015; Sampilo, 2014), and a number of these are based in the UK (Arshad, 2007; Eyre, 2014; Gonzalez & Gill, 2015; Henderson, 2010; Maynard *et al.*, 2009; Trigwell, 2011). However, few of these studies reported a structured or systematic process of mixed methods analytical integration.

Integration of quantitative and qualitative components is a requirement of mixed methods research (Creswell & Plano Clark, 2011; Teddlie & Tashakkori, 2003). Most mixed methods research integrates at the interpretation stage, or the sampling stage (O'Cathain *et al.*, 2007). However, mixed methods commentators claim that much mixed methods research fails to maximise the potential of these designs through a lack of analytical integration of qualitative and quantitative findings (Bryman, 2007; Fetters & Freshwater, 2015; Guetterman *et al.*, 2015; O'Cathain *et al.*, 2007; Onwuegbuzie, 2012). The value of integration in mixed methods is its ability to *"produce a whole through integration that is greater than the sum of the individual qualitative and quantitative parts."* (Fetters & Freshwater, 2015 p.116). However, a review by O'Cathain *et al.* (2007) found that only around a fifth of mixed methods reports in a UK health sciences setting employed analytical integration. Improved reporting of analytical integration in mixed methods studies provides greater transparency, greater impact of the findings and help to build the currently limited knowledge base on integration methods (Johnson *et al.*, 2017; O'Cathain *et al.*, 2010).

Given the complex and nuanced nature of both childhood obesity, and of ethnicity as a variable within health research, it was felt that a stage of mixed methods analytical integration was necessary to illustrate this complexity and fully explore childhood obesity across ethnic groups in Coventry.

6.3 Study aims

The current study utilised an explanatory sequential mixed methods design, with the aim of exploring childhood obesity across ethnic groups in Coventry. The aim of the mixed methods approach was for latter study components (qualitative) to provide explanations for the findings from the initial (quantitative) study component, through expansion. Within this analysis, an aim was to assess the 'fit' of the integration i.e. the extent to which findings cohere (Fetters *et al.*, 2013) and address any divergence in data. A final aim was to design and appraise an integration method for systematically integrating qualitative and quantitative findings.

6.4 Methods

6.4.1 Overview of study components

This overall mixed methods study consisted of four study components: two quantitative components (systematic review and NCMP analyses) and two qualitative components (with children and parents). Table 6.1 provides an outline of the aims and approaches used within these components. The findings from each study component provide insights into 'universal factors' influencing childhood obesity, and 'ethnic-group specific factors'. In general, the ethnic-group specific analyses focus on the broad Black African and Caribbean and South Asian ethnic groupings. This focus is for two reasons: these groups represent the largest minority ethnic groups in Coventry, and these groups also had high odds of overweight and obesity following quantitative analyses, so were purposively sampled in the qualitative phase.

Table 6.1 Mixed methods study components

Study	Research aims	Study and approach	Sample
Study component 1	1. To identify the factors that influence overweight and obesity in children aged 4 – 11 years (primary school age) from minority ethnic groups within the UK. 2. To review the evidence-base with consideration of the quality of the evidence and the limitations in the existing literature.	Systematic review of the quantitative literature	Primary school aged children in UK
Study component 2	To identify: 1. Are there any differences in adiposity across ethnic groups, and do these vary by sex or over time? 2. Is there a substantial effect of school or neighbourhood upon adiposity as a whole and are these related to school or neighbourhood characteristics? 3. Does the effect of school and neighbourhood characteristics upon adiposity vary across ethnic groups? 4. Does the combination of all these elements therefore account for the differences in adiposity seen across ethnic groups? 5. To what extent does height attenuate any differences in zBMI by ethnic group? 6. To what extent do zBMI values adjusted for ethnic variation in body composition influence patterns of ethnic variation observed in childhood zBMI? 7. To what extent does an alternative reference population and cut-offs for classifying child weight status influence patterns of ethnic variation observed in childhood overweight and obesity?	Multilevel modelling of NCMP data n = 54,170	School children aged 4-5 and 10-11 years in Coventry
Study component 3	To explore children's perspectives and experiences of health, diet, physical activity and weight	Interviews with children using draw, write and tell technique n = 26	Ethnically diverse, deprived areas, aged 9-10 years in Coventry
Study component 4	To explore parental perspectives and experiences of family health, diet, physical activity and weight	Focus groups and interviews with parents from ethnic groups with high risk for obesity n = 35	Focused recruitment of Black African and Caribbean, South Asian, White British and White other parents, deprived areas in Coventry

6.4.2 Rationale

This analytical integration aimed to better explore childhood obesity across ethnic groups in Coventry through 'expansion' of the mixed methods study components. As Greene *et al.* (1989) outline, an expansion approach seeks to:

> "extend the breadth and range of inquiry by using different methods for different inquiry components". (p.259)

In this case, the qualitative study components aimed to provide an insight into the cultural and contextual basis for ethnic disparities in childhood obesity, which was not considered possible through quantitative investigation alone. However, researchers have been critical in the past of 'expansion' rationales for failing to integrate analysis and interpretation (Greene *et al.*, 1989).

6.4.3 Mixed methods analytical integration techniques

This analytical integration made use of a combination of several techniques including: a joint display (Guetterman *et al.*, 2015) and following a thread (O'Cathain *et al.*, 2010). Joint display offers a visual means of integration, and enables the researcher to compare and contrast data from across several study components (Guetterman *et al.*, 2015). Following a thread is characterised by taking a theme from one component and following it across the other components (O'Cathain *et al.*, 2010). There was also an element of 'triangulation protocol' in the integration, since data coherence (or 'convergence') was also assessed and is discussed in relation to the findings in the discussion section (O'Cathain *et al.*, 2010).

6.4.3.1 Process of analytical integration

An overview of the process of integrating findings is provided in Figure 6.1 and discussed in greater detail in the text below.

Figure 6.1 Process of mixed methods integration

Step one: Selection of data

a) Identified key findings/'threads' arising from study component 2 (NCMP analyses) and tabulated these in column one of the joint display table
b) Sought data from study components 1, 3 and 4 that related to study component 2 findings/'threads', tabulating these in three columns in the joint display table
c) Revisited original data retrospectively to identify any additional data supporting 'threads'
d) Data described as absent if no findings from a particular study component arose
e) Three joint display tables produced: 1) universally-applicable findings; 2) findings applicable to Black African and Caribbean ethnic groups; and 3) findings applicable to South Asian ethnic groups

Step two: Assessment of integration fit

a) Each set of findings was reviewed to assess:
   1. the explanatory value of findings from study components 1, 3 and 4, related to those from study component 2
   2. data coherence/agreement across all study components
b) Columns were added to the joint display tables in which 'integration codes' were assigned to summarise the 'explanatory value' and 'data coherence'

6.4.3.1.1 Step one: Selection of data

Mixed methods integration allows some selectivity in data to be integrated (Johnson *et al.*, 2017). On this basis, selection of data was undertaken, using the findings from study component two (NCMP analyses) as the starting point, and seeking data from other study components that added some explanatory value to these findings (or data that were seemingly at odds with these findings), through the 'following a thread' technique. Original data from study components 1, 3 and 4 were revisited retrospectively to seek any additional support or disagreement that was not reported in the individual chapters preceding this integration.

To support the organisation and interpretation of findings, the selected data were tabulated in a series of joint displays: 1) universally-applicable findings; 2) findings applicable to Black African and Caribbean ethnic groups; and 3) findings applicable to South Asian ethnic groups. Black African and Caribbean and South Asian ethnic groups were purposively sampled in study component 4 (qualitative study with parents) based on the increased odds for ov/ob for these ethnic groups identified in study component 2 (NCMP analyses). These 'working' joint display tables aided synthesis of the key mixed methods findings.

6.4.3.1.2 Step two: Assessment of integration fit

Since an additional aim of the mixed methods analysis was to assess the 'fit' of the integration, two additional columns were added to the joint display that aimed to assess integration fit using two 'integration codes': 1) an 'explanatory value' code and 2) a 'data coherence' code. These codes were designed for the purpose of this study, but were developed from terms defined by Fitzpatrick (2016), Fetters *et al.* (2013) and Bazeley (2018) in their descriptions of integration fit and/or data convergence. Definitions of these codes are detailed in Table 6.2. 'Explanatory value' described the extent to which the findings from study component 2 were explained by the findings from the other study components. 'Data coherence' assessed the extent to which findings from each study component agreed with one another. In-keeping with a triangulation protocol, these codes were then used in the discussion to explore possible explanations for relationships between components.

Table 6.2 Definition of codes used to assess integration fit

Code	Definition
Explanatory value codes	
Explanatory	data appear to explain/add depth to study component 2 findings
Contradictory	data appear to contradict/be at odds with study component 2 findings
Mixed	some data are explanatory and some are contradictory, suggesting nuances in the topic
Data coherence codes	
Agreement	where study components show agreement/harmony
Partial agreement	where some study components show agreement, but data are absent from some study components, or some data are also dissonant
Disagreement	where findings from each component are inharmonious/inconsistent

Absent	where findings relate to one study component only

6.5 Results

Three joint displays were produced to support the synthesis of data, with a total of eleven key findings (or 'threads'):

- four universal threads: age, gender, school and neighbourhood
- three threads specific to the Black African and Caribbean group: ethnicity and culture (scenario one), ethnicity and culture (scenario two) and markers of SEP
- four threads specific to the South Asian group: ethnicity and culture (scenario one), ethnicity and culture (scenario two), age and gender.

The working joint display tables are provided in Appendix 27 – Appendix 29 and the subsequent synthesis of data is discussed in detail below.

6.5.1 Synthesis of mixed methods findings

A description of each thread is provided below for universally-applicable findings, those applicable to Black African and Caribbean ethnic groups and those applicable to South Asian groups. Each section is followed by tables with example quotes from qualitative studies and the presentation of a 'logic model' outlining the proposed pathways and mechanisms of action within each thread.

6.5.1.1 Interpretation of logic models

Logic models of the relationality of the key findings to one another are provided for each ethnic group to support the linking of elements and comprehension. Findings from study component 2 (NCMP analyses) are highlighted in green boxes (*'NCMP outcomes'*), quantitative findings from study component 1 (systematic review) that support or refute NCMP outcomes are in blue boxes (*'systematic review outcomes'*), and potential explanatory findings from the qualitative studies and systematic review are provided in orange boxes (*'explanatory factors'*). On this basis, all elements contained within boxes come directly from the data analysed within this study (the related study component is provided as a number in brackets for each box). A green plus sign is provided where there is apparent support between two elements, whilst a red cross is provided where findings appear to refute one another.

Lines and arrows are indicative of related elements and directional relationships. In order to make sense of the relationships, potential mechanistic processes are described in italics (*'proposed mechanisms'*). Those provided in boxes come directly from the current study, whilst those not contained within boxes are *hypothetical* mechanisms or those apparent in the existing literature, explored in the discussion section.

6.5.1.2 Universal findings

6.5.1.2.1 Thread 1: Age

Key findings

Odds of ov/ob increased across the course of childhood. The NCMP analyses observed a higher prevalence of ov/ob (23%, 95% Confidence Intervals: 23%-24% in reception versus 35%, 95% Confidence Intervals: 34%-36% in year 6) and a higher mean zBMI (0.34, SD: 1.09 reception year versus 0.52, SD: 1.24 in year 6) in year 6 across all groups.

Explanatory value: explanatory

The qualitative parental study provided some insight into why this may be the case. Illustrative quotes are provided in Table 6.3.

Opportunities for physical activity (PA): Parents reported fewer opportunities for PA as children get older in school, particularly due to a focus on academics over physical activity. This may result in lowered physical activity levels (PAL) over childhood.

Independence: Older childhood was viewed as a phase of increasing independence and responsibility in relation to food behaviours, which parents felt would result in poorer dietary choices at school and increases in fast food consumption during the after-school period. Greater autonomy in food choice over childhood may therefore result in increased energy consumption.

Data coherence:

Study 1: Partial agreement The systematic review shows only partial agreement with NCMP analyses: increases in zBMI between 3 – 7 years were observed only in Asian and Black children but not White British children (-0.07, SD: 0.02, p<0.001) (Martinson *et al.*, 2015). The inclusion of gender showed increases in girls relative to boys (+0.11, SD: 0.01, p<0.001).

Studies 3 and 4: Absent There was a lack of agreement between child and parental studies due to the absence of data in the child study with regards to age. However, only one age group was included in the child sample, prohibiting comparisons across age groups.

6.5.1.2.2 Thread 2: Gender

Key findings

Boys had higher odds of ov/ob than girls. The NCMP analyses identified that boys had a high prevalence of ov/ob versus girls for both year groups. Being a boy was significantly associated with higher odds for ov/ob after adjustment for ethnicity and school deprivation, but only for older children (OR = 1.16, 95% Credible Intervals: 1.10,1.22; p<0.001). Being a boy was also associated with a higher zBMI in year 6 (+0.14, 95% Credible Intervals: 0.11, 0.17; p<0.001).

Explanatory value: explanatory

Possible explanations are found in the qualitative data, supported with illustrative quotes in Table 6.3.

Body size ideals: There appeared to be greater societal pressure on girls to be a lower weight, identified by a small number of children and parents, and parents spent more time providing reassurance to girls regarding their weight. For boys, strength and muscle was an important part of a healthy body ideal, which was less often the case for girls. At first glance, this may seem at odds to the idea of boys being at greater risk of overweight (suggesting a preference for lean body shapes), however, strength and muscles are both associated with a 'bulky' body size aesthetic, and boys may therefore strive to achieve a larger body size in pursuit of strength.

Data coherence:

Study 1: Absent The systematic review did not provide any data that corresponded to this finding due to the lack of sub-group analyses in included studies.

Study 3 and 4: Agreement There was agreement between child and parental data in relation to girls' body size ideals.

6.5.1.2.3 Thread 3: School

Key findings:

School environment plays a minimal role in determining adiposity: In NCMP analyses, the extent to which schools varied in zBMI was small, with much of the variation observed at the individual level. School-level variance was stronger in reception year, accounting for 0.7% and 0.4% of the variance in reception and year 6 respectively. The inclusion of a measure of number of fast food outlets around the school showed no association with child zBMI.

Explanatory value: contradictory

Data within this sub-theme were contradictory. Some example quotes from qualitative study components are provided in Table 6.3.

Role of school: Despite the lack of school contribution in the quantitative data, the qualitative data showed that children and parents strongly favoured the role of the school in helping to support healthy behaviours and prevent childhood obesity. Parents described a negative influence of fast food outlets around schools, and a number gave examples of their own children/grandchildren making use of fast food takeaways with school friends/after school. Children also highlighted a negative influence of fast food outlets, but only one discussed this in specific relation to the after-school period.

With regards to a greater school effect in reception year vs year 6, there are few potential explanations for this in the data, however, one point to note from parental interviews was that parents felt there were fewer opportunities for children to be active in school in later childhood, due to the focus on academic performance. It may be that there is more school-level variation in the physical activity provided for reception age children (where the focus is play) versus year 6 children (where the focus is attainment).

Data coherence:

Study 1: Absent The systematic review did not contribute towards 'school' as a thread as no included articles explored the role of school factors upon ethnic group differences in weight status.

Study 3 and 4: Agreement Child and parental data showed strong agreement in relation to the perceived important role of schools.

6.5.1.2.4 Thread 4: Neighbourhood

Key findings:

Deprivation strongly influences health behaviours: Deprivation was positively associated with weight status in the NCMP analyses (+0.02

95% Credible Intervals: 0.01,0.03, $p<0.001$ in reception year and +0.03, 95% Credible Intervals: 0.02,0.04, $p<0.001$ in year 6).

Explanatory value: explanatory:

In the qualitative study components, parents and children provided some insights into the potential mechanisms underlying the relationship between deprivation and weight status (see Table 6.3). As a composite measure, IMD incorporates objective measures of neighbourhood crime, and quality of the local environment e.g. road traffic accidents.

Safety and crime: In the qualitative study components, safety and crime arose as a dominant theme, particularly for parents, with safety and crime concerns acting to restrict children's independent outdoor play in particular.

Neighbourhood aesthetics: This was also a factor for children, with clean, traffic-free spaces important for enabling independent outdoor play.

Two additional explanations were described by parents and children, and have been detailed here due to their documented relationship with deprivation:

Fast food outlets: Parents and children reported an abundance of fast food outlets in the neighbourhood, which they felt made unhealthy choices easy.

Access to green space and leisure facilities: Parents reported limited access to green, open space and leisure facilities, which they felt contributed to low physical activity levels. In addition, the current qualitative data suggest that the lack of access to a car (a component of area deprivation in some measures) inhibits travel to leisure facilities, with public transport viewed as a burden (that further compounds the mental effort required to visit a leisure centre), and so car ownership may mediate the relationship between distance to leisure facilities and physical activity.

On the other hand, parents and children also reported that a lack of personal transport resulted in a greater reliance on walking, which would contrastingly result in high physical activity levels and lowered adiposity for those from deprived areas.

Data coherence:

Study 1: Agreement Findings from one study (Townsend & Ridler, 2009) in the systematic review also observed a positive relationship between deprivation and odds of overweight (OR = 1.01, 95% Confidence Intervals: 1.01, 1.01; $p<0.01$).

Studies 3 and 4: Partial agreement There was strong agreement between parents and children with regards to the perceived role of the neighbourhood in keeping families healthy. However, neighbourhood *aesthetics* appeared to be a factor for children only, and not parents.

Table 6.3 Example quotes from qualitative data: universally-applicable mixed methods findings

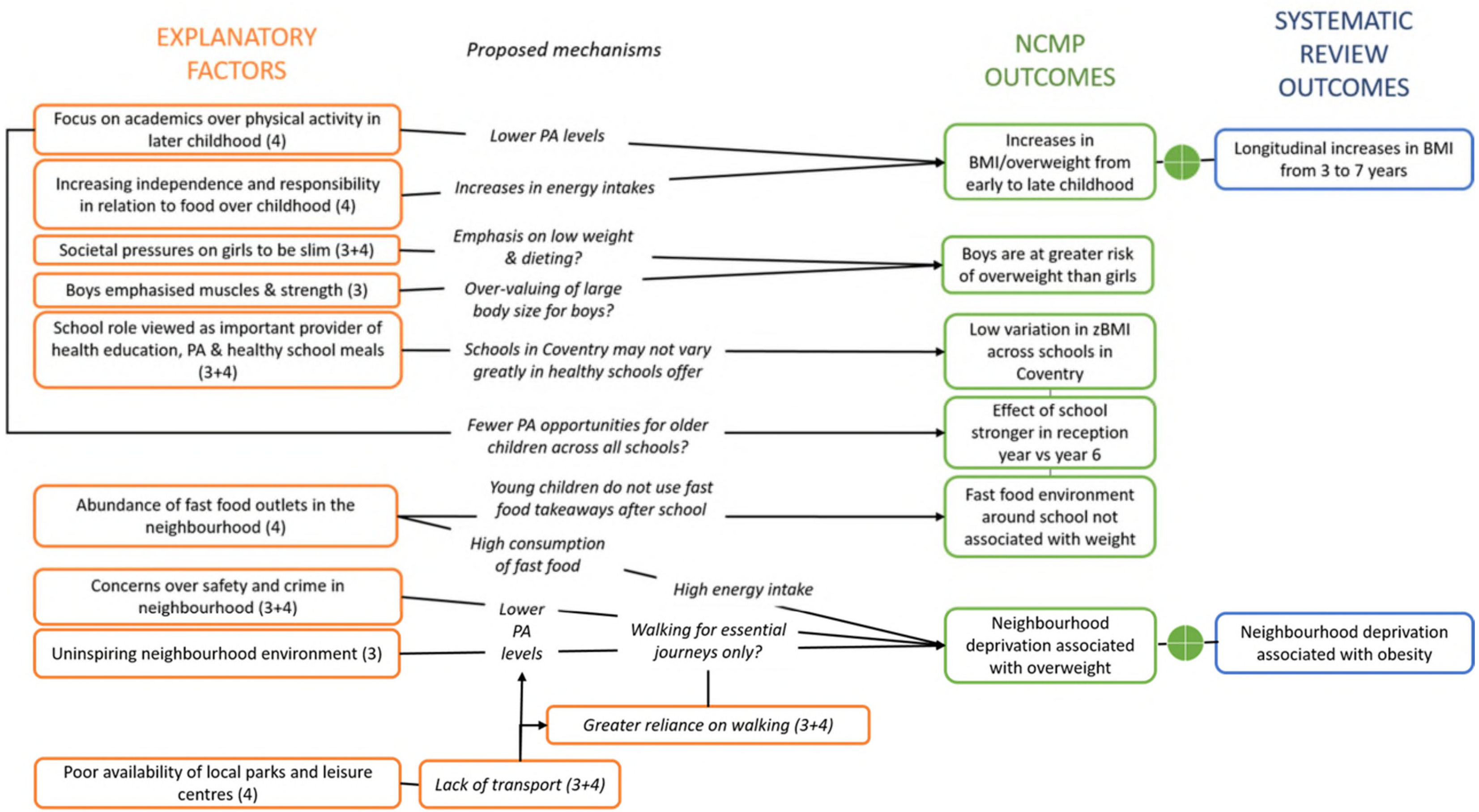
Thread	Illustrative quotes
Age	ID26: "But with the teenagers, you keep telling them but they do…" ID24: "The opposite" ID26: "The opposite as well" ID30: "Tell them to eat junk food, then they won't!" [Laughs] ID24: "Because they'll do the opposite!" *ID26, mother, British Muslim, country of birth: Pakistan, faith: Muslim; ID24, mother, Asian Indian, country of birth: UK, faith: Muslim; ID30 mother, Asian Indian, country of birth: UK, faith: Muslim [parent quote]* ID24: "Yes, but there are some after-school activities yes and she does do that as well actually" ID29: "Yeah, but that's more for primary schools, not secondary schools. Secondary schools don't do it, they've got after-school clubs, but they're like…" ID24: "Maths and English and French" *ID24, mother, Asian Indian, country of birth: UK, faith: Muslim; ID29, mother, British Muslim, country of birth: UK, faith: Muslim [parent quote]*
Gender	"I think with girls it's more, I think it becomes like a competition with their peers as well, the way you look and how your body is. Whereas boys, they don't bother really in that sense. And I think sometimes it's the media as well, like the celebrities as well, and the magazines, and in the news. You'll hear stories like girls losing weight, or a celebrity lost this much weight after having a baby, doesn't seem like she had a baby. And that does actually, I think, quite affects a lot of girls, not just the girls, I think it's the women as well. It affects them as well in that sense that people, if you've got a lovely figure then everybody says 'wow'. And if you haven't got a lovely figure then obviously it just, I think people, it affects their confidence in that way as well." *ID23, mother, Pakistani, country of birth: UK, faith: Muslim [parent quote]* "In this world people, all the adults and other countries, all the countries, you're skinny, you're beautiful, you're going to make a lot of money... They say that beautiful is all you have to be to get... to be, well, amazing." *ID3, Girl, Black African, Non-UK born, 2 parents born abroad [child quote]*

Thread	Illustrative quotes
School	"Well, they [the school] don't just like say, 'oh this person needs to this to be healthy', they give the same information to everybody, so not just them, because then that's just like a bit mean like you're like picking on somebody… So I think they tell the same information to everybody which benefits us all." *ID24, Girl, Mixed ethnicity (White British and Asian Indian), UK born, 1 parent born abroad [child quote]* "My son, he's in secondary and he will be like, 'oh all my friends get chips after school', and I'm… and he's like, 'mum can I have some money to buy chips after school'. And I'm like, 'do you think that's really a good idea, wouldn't you rather come home and eat home cooked meal?' 'But all my friends…'" *ID1, mother, Black British African, country of birth: Kenya, faith: Christian [parent quote]*
Neighbourhood	"you have to protect them [children] from people that are roaming around on the streets doing bad things, and the weather not being good, and too many cars. Even sometimes you want, even in summer, you want your kids to be outside the front of your house just playing. But you're thinking about that stupid driver, sorry to use that word, that stupid driver who is going to be speeding, and you never know when your son or your daughter is going to try and cross the road, you know?" *ID9, mother, Black African, country of birth: Non-UK born, faith: Christian [parent quote]* "There isn't any leisure centres for him [the unhealthy child]. There isn't any parks, nothing. He's all... it's very messy as well and there's nothing there." *ID7, Boy, Indian, UK born, 2 parents born abroad, (IMD decile 2) [child quote]* ID29: "We've got too many takeaway shops haven't we? I know you don't force anyone to go in, but 'oh wow, chicken and chips, a pound'" ID30: "It's the easy option isn't it?" *ID29, mother, British Muslim, country of birth: UK, faith: Muslim; ID30 mother, Asian Indian, country of birth: UK, faith: Muslim [parent quote]* ID9: "Even if you are going there [the leisure centre], you are thinking about the cost of going there, and the frustration. Like, whether it's going to rain, are you going to get the bus to get there on time… it's, oh god" Interviewer: "There's a lot to think about?" ID9: "Yeah. And then you just go, stay at home. And you think about the distance of going there, and even if like, we should go to the park, too many people are in the park. … and it's too crowded. It's like there's not enough things for you to play with, or stuff like that." *ID9, mother, Black African, country of birth: Non-UK born, faith: Christian [parent quote]*

6.5.1.2.5 Logic model: Universally-applicable findings

Figure 6.2 provides a figurative overview of the key universal findings from across the four study components in relation to one another.

Figure 6.2 Logic model for universal mixed methods findings



6.5.1.3 Findings related to Black African and Caribbean ethnic groups

Key findings

Patterns in weight status were dependent upon measure used: Two key findings have been grouped under the umbrella theme 'ethnicity and culture'. The NCMP analyses for Black African and Caribbean children suggest two potential scenarios, dependent upon how adiposity was assessed. In Part 1 and Part 2 of the analyses, children from Black African backgrounds had a high zBMI and high odds of ov/ob compared to White British children, whilst Black Caribbean children (girls only) had a high odds of ov/ob versus White British children.

However, the interpretation of NCMP analyses is complicated by the potential for mis-estimation of adiposity in Black ethnic groups. In Part 3 of NCMP analyses, when using Adj zBMI values adjusted for fat mass (Hudda *et al.*, 2017a) or when analyses were adjusted for the influence of height, the nature of ethnic group differences changed, with Black African and Black Caribbean children having a significantly lower zBMI versus White British children.

The findings from study components 1, 3 and 4 must therefore be considered in light of either scenario.

6.5.1.3.1 Thread 5: Ethnicity and culture (Scenario one)

Scenario one refers to the finding that children from Black ethnic backgrounds have a higher odds for ov/ob versus White British children when using unadjusted zBMI values.

Explanatory value: explanatory

Some data from study components 1, 3 and 4 provide potential explanations for this scenario, with illustrative quotes in Table 6.4.

Body size ideals: There was an apparent cultural valuing of a large body size in African cultures, highlighted by parents in the current study, which may result in an over-valuing of large body size, and reluctance to address weight gain. Few ethnic group differences for a healthy body aesthetic were identified in children, with the exception of a low proportion of Black African children describing a healthy body as a 'muscly' or 'strong' body compared to White British children, although the small sample means caution must be applied in making inferences from this finding (especially due to gender differences in the sample, and its qualitative nature).

Hospitality: The cultural importance of hospitality for African groups, and the role of food in providing hospitality, meant that social visits resulted in over-eating.

Valuing of 'treats': Discussion of 'treating' children with foods perceived as less healthy was more prominent in the data of children and parents from African backgrounds than in other groups. Although statistical inferences cannot be made due to the qualitative nature of these two study components, it may be the case that treat foods are highly valued in Black African families. The use of the term *"treat"* throughout parents' descriptions provides some evidence of the status given to sweet foods, and phrases such as *"in Africa you only tend to get chocolate on your birthday"*. The systematic review also identified that Black African and Caribbean parents reported significantly higher 'food-approach' behaviours in children. This measure of 'food approach' included components such as overeating/eating in the presence of fullness, high enjoyment of food and emotional overeating, which was positively associated with child BMI (Blissett & Bennett, 2013).

Ethnic differences in parenting practices: Black African and Caribbean parents/carers in study component 4 (parent qualitative study) more often discussed the role of parental discipline in managing child health behaviours compared to other groups. One study in the systematic review also found that Black African-Caribbean parents exhibited more restrictive food practices than White British parents, an approach that was positively associated with BMI (Blissett & Bennett, 2013). Although restrictive food practices were intended by parents in the current study to curb unhealthy dietary intake, it is apparent from the systematic review that the opposite may be true.

Climate and community: Parents who had migrated to the UK more often described weather and climate as a barrier to physical activity, which may additionally contribute to low PAL for Black African or Caribbean children whose parents had migrated. Migration likely plays a key role in the perception of bad weather as a barrier to PA: in their native environments, physical activity for children was described as largely incidental, and the result of having an outdoor lifestyle, which was enabled by the climate and an active social and community life.

In the UK, poor weather and a lack of community limits the role the ‘outdoors’ is able to play in maintaining a physically active lifestyle, and so migrants were required to adapt their conceptualisations of physical activity to a pursuit that requires more thought and effort e.g. membership of clubs, travel to venues.

Access/availability of traditional foods: The role of traditional foods in the diets of African families who have migrated to the UK is another potential contributor. Parents from African backgrounds cited difficulties in accessing traditional foods, and child preferences for ‘British’ foods, both of which limit migrant families’ ability to maintain healthy traditional dietary practices.

Parental weight: Parental weight may be a contributor or mediator on pathways to childhood overweight for Black African and Caribbean children. This was highlighted in the systematic review in which one study found that mothers' BMI mediated relationships between sociodemographic factors and BMI in Black African and Caribbean children (Zilanawala *et al.*, 2015). In study component 4 (parent qualitative study), the majority of parents providing their ethnicity (or country of origin) as Black, African or Caribbean (including mixed) were identified as overweight or obese based on parental self-report of height and weight. However, only a small number of Black African and Caribbean parents described concerns about their own weight (n=3). It may be that maternal obesity is the stronger determinant of increased risk for child overweight in Black African and Caribbean families, and that the potential explanatory factors discussed here e.g. cultural valuing of large weight, role of food in hospitality, may operate indirectly to influence childhood weight status via the parental pathway (see Figure 6.3).

Data coherence:

Study 1: Agreement. This scenario was supported in the findings from the systematic review, which consistently found a high prevalence of overweight and/or obesity in Black African Caribbean groups, especially the Black African group (ranging from 11.1% - 18.7% obese), vs either White British children (5.1% - 5.5% obese) or the general population.

Studies 3 and 4: Absent. Child and parental reports generally showed low agreement with one another due to the absence of ethnic group-specific data from children's data e.g. cultural valuing of a large body size was not overtly apparent in children's data.

6.5.1.3.2 Thread 6: Ethnicity and culture (Scenario two)

The alternative scenario was that Black African and Caribbean children in fact had a lower risk of adiposity versus White British children, once diagnostic factors were taken into account (i.e. using Adj zBMI values in which BMI was adjusted for fat mass, or when adjusting for the influence of height).

Explanatory value: Explanatory

In this scenario, there is some data from the qualitative study components that provide potential explanations, and Table 6.4 provides some illustrative quotes from the qualitative study components.

Traditional diet: A healthy African and Caribbean traditional dietary pattern, described by parents as abundant in vegetables (e.g. okra, spinach) and starchy foods (e.g. cassava, yam, rice, semolina, maize, potatoes), based on organic, seasonal and home-grown produce, and home-made, may protect against adiposity for these groups. This was echoed in children's data: Black African children in particular identified 'fast food' or takeaways as unhealthy and considered homemade food as healthy (although numbers were small). There was a strong desire to retain traditional dietary patterns, and this seemed to reflect parents' nostalgia for home and the symbolic nature of food in heritage-maintenance. In theory, this desire, coupled with healthy traditional dietary practices, may provide some explanation for the proposed low Adj zBMI (when using fat mass-adjusted values) in children from Black African and Caribbean backgrounds.

Data coherence:

Study 1: Disagreement The systematic review does not support this scenario, generally finding Black, African and Caribbean ethnicity to have a higher prevalence of excess weight compared to other groups (Brophy *et al.*, 2009; Kelly *et al.*, 2012; Martinson *et al.*, 2012; Smith *et al.*, 2012; Zilanawala *et al.*, 2015).

Studies 3 and 4: Partial agreement There was some agreement between parental and child responses, with both emphasising the importance of homemade food for health. However, children did not often describe specific African dietary practices.

It is important to note that as scenario one and two are oppositional findings, the 'explanatory' factors supporting scenario one will be 'contradictory' for scenario two, and vice versa.

6.5.1.3.3 Thread 7: Markers of SEP

Key findings:

Inverse relationship with IMD for children from Black ethnic backgrounds: The current NCMP analyses found an inverse relationship between IMD and weight status for Black African children (a low zBMI and low odds of ov/ob as IMD increased), which is at odds with established deprivation gradients in obesity. However, this was only the case in reception year children, and stratified analysis showed that this relationship was apparent for boys only.

Explanatory value: explanatory

The parental qualitative study component provides some potential explanation for a protective relationship of socioeconomic position and adiposity in the black African group.

Symbolic nature of large body size: The cultural valuing of a large body size previously described was driven by a belief that a large weight status was indicative of being wealthy and well-fed (see section 5.5.2.2.2) Larger body size may therefore be pursued across all SES groups as a symbol of high status.

Life in Africa: In addition to cultural beliefs around weight and success, the qualitative data suggest that in African countries, obesogenic behaviours may be accessible only to those from high socioeconomic backgrounds. A small number of parents in the qualitative study component described experiences of hardship in their native environments, related to a lack of material wealth, which would be considered protective against obesity e.g. food scarcity, walking long distances/lack of access to a car, physically-demanding household chores and having to grow their own produce (rather than purchase it from shops). One parent also described takeaway food in Africa as *"for the rich"*, whilst another parent claimed *"In my country organic food* [is] *for poor people".* This would reinforce beliefs that a large body size is indicative of wealth and success.

Socioeconomic gradients in health and the influence of migration: The qualitative data provide an additional layer of complexity. As described in earlier sections, a cultural valuing of a large body size was seen as a traditional viewpoint, whilst parents themselves often did not subscribe to this traditional belief, suggesting a 'transition' in cultural beliefs upon migration (in the UK, overweight status is associated with poverty). In addition, parents described dietary transitions following migration based on economic capacity ('British life'), for example, lower consumption of fruit and vegetables due to their expense, higher consumption of 'treat' foods and fast food due to their abundance and low cost. In addition, the physical demands of life were lessened upon moving to the UK, due to access to material goods (e.g. a car, TV, automated household appliances).

Parents were also reluctant to allow children to play outdoors in the UK (partly due to bad weather and a lack of the protective nature of a strong sense of community) and reported indoor leisure activities/clubs as unaffordable. These factors imply that typical UK socioeconomic gradients in health are applicable i.e. low socioeconomic status linked to unhealthy diet and low physical activity levels.

The systematic review contributes further to this thread however, by identifying differences in socioeconomic gradients for children of UK-born and foreign-born African parents. One study included in the systematic review found that low income was protective for children of foreign-born Black mothers only (Martinson *et al.*, 2012). On the other hand, the same study in the systematic review found a significant interaction between education and Black ethnicity (a protective effect of low education) in children of UK-born mothers only (Martinson *et al.*, 2012). However, the coefficients produced by Martinson *et al.* (2012) provided for children of foreign-born Black mothers suggest the same socioeconomic pattern, but the findings lacked statistical significance.

Data coherence:

<u>*Study 1: Partial agreement*</u> A number of studies included in the systematic review echoed those from the NCMP analyses by identifying a similar gradient across several markers of SEP. This included: 1) parental education (Brophy *et al.*, 2009; Martinson *et al.*, 2012) (one out of four included studies exploring this variable finding a significant protective effect of low education for Black groups and one study found high prevalence of obesity at low, middle and high levels of education for the African group); 2) parental income (Brophy *et al.*, 2009; Martinson *et al.*, 2012); (the two included studies exploring this variable found high risk of adiposity in high income Black/African groups, although this was significant in only one study); and 3) socioeconomic class (Thomas *et al.*, 2012)(one study exploring this variable found a positive relationship between social class and adiposity for Black African-Caribbean children). On the other hand, a number of studies included in the systematic review reported no ethnic group differences in socioeconomic gradients, although there were methodological and reporting issues with these studies, such as not exploring interactions between SEP and ethnicity (Karlsen *et al.*, 2014), describing inconsistencies in ethnic group patterns but not reporting the nature of these differences (Higgins & Dale, 2012), or potentially being out-of-date (Rona & Chinn, 1987).

<u>*Studies 3 and 4: Absent*</u> There was low agreement between parental and child data within this theme. Children from Black African and Caribbean groups generally did not discuss culturally-held traditions or beliefs, and did not describe experiences of migration, although this is not surprising

since the majority of Black African children were UK-born (although most were the children of migrant parents).

Table 6.4 Example quotes from qualitative data: mixed methods findings for Black African and Caribbean groups

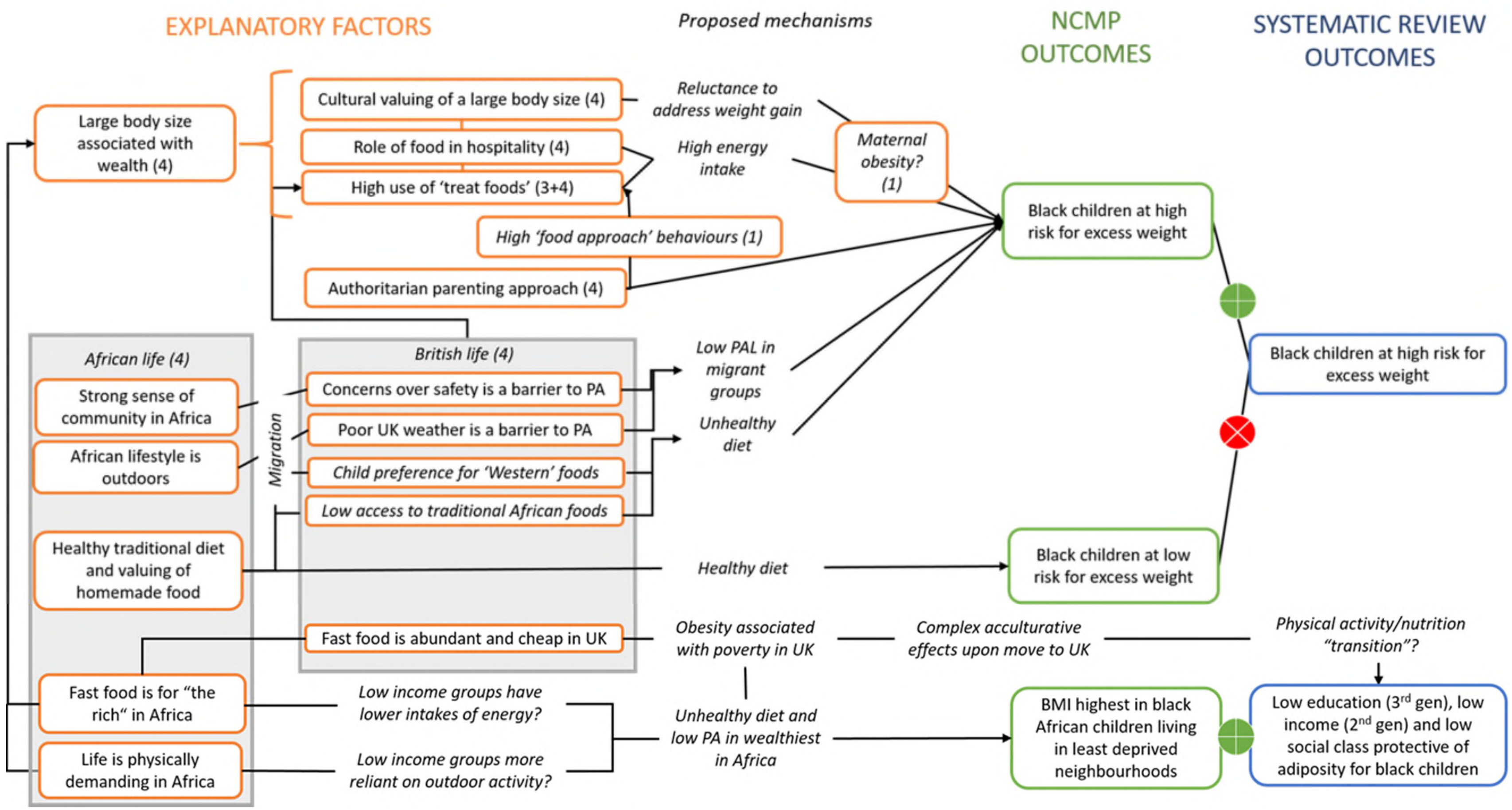
Thread	Illustrative quotes
Ethnicity and culture (scenario one)	"…well you need fat in your body because it's not good to just be… to have no fat, like at least a bit of fat. You don't want to be skin and bones. And the fruit and the veg and the meat, protein, and bread, carbohydrates, the fruit and the veg, just drop in a few sweets for the fatty and the sugars." *ID3, Girl, Black African, Non-UK born, 2 parents born abroad [child quote]* "Food is like an African tradition so it is not very easy when you have to visit people and have to see other people" *ID2, mother, Black African, country of birth: Zimbabwe, faith: Christian [parent quote]* "My childhood was back home in Africa, it's quite different …And it's open space, and stuff. So it's quite different from now. And you can't give them that now, because you have to protect them from people that are roaming around on the streets doing bad things, and the weather not being good, and too many cars. Even sometimes you want, even in summer, you want your kids to be outside the front of your house just playing. But you're thinking about that stupid driver, sorry to use that word, that stupid driver who is going to be speeding, and you never know when your son or your daughter is going to try and cross the road, you know." *ID9, mother, Black African, country of birth: Non-UK born, faith: Christian [parent quote]* But in Africa you're always visiting relatives and friends, kids are outside playing and you don't have time to just sit around and do nothing and eat. But here we just sit here… I've had a cold for a week and all I did is just sit here and eat, you know. Yeah, the weather doesn't help at all. *ID2, mother, Black African, country of birth: Zimbabwe, faith: Christian [parent quote]* "Sometimes our children don't like our cultural food, so sometimes we go with what they like" *ID8, father, Black African, country of birth: Angola, faith: Christian [parent quote]* "If you had African people in this room they would be shocked, because like sugar is like a big thing in Africa. And for me to have tea without sugar has just like shocked my grandmother to death." *ID2, mother, Black African, country of birth: Zimbabwe, faith: Christian [parent quote]*
Ethnicity and culture (scenario two)	"Especially I find that with the West Indian families, because brought up, you know, African, West India, the same thing, fresh products. We're not used to these, what do you call it, artificial erm food, processed food. We're all fresh food. So everything is grown. Everything is picked from the tree and picked from the ground". *ID14, ethnicity not stated, country of birth: Jamaica, faith: Christian [parent quote]* "…I don't eat as much as I used to eat in Africa, but I put weight on when I'm here. Again I think that goes to the food not being organic and not much activities that I do here, you know."

Thread	Illustrative quotes
	ID2, mother, Black African, country of birth: Zimbabwe, faith: Christian [parent quote]
Markers of SEP	ID12: "What I've noticed, back at home people normally there's no Macdonald's or all those sorts of things. There is for people who are richer, but most in people who are poor they tend to eat what is available in the house, they don't even go to the shops to buy food, but they only eat what is being harvested in the homestead, like in the farms. That's what they normally eat, they don't go buying things from the shop. So there's a big difference here. I think in this country people they can afford food that is expensive, whereas in my… where I come from people they don't afford food that is very expensive, they eat whatever is available in the house, that's what they will eat. So there is no problem of obesity, no." Interviewer: "And the food that's available at home, that's healthier?" ID12: "It's healthy food because it's from the fields. They do plough in the farms, so everything that is being eaten is organic from the farms." *ID12, mother, Black African, country of birth: Zimbabwe, faith: Christian [parent quote]* "[In Africa] after you have your meal you have to wash your plate, you have to clean the house, so that is sort of like an activity, a sort of like exercise in a way. But here all we do is just eat your food, throw your plates in the dishwasher, you sit the TV and you do nothing else" *ID2, mother, Black African, country of birth: Zimbabwe, faith: Christian [parent quote]* "For physical activity, I think African children are more active. Because whatever they are doing, if you're collecting water, you don't collect from the tap, you go to a far-away whereby you carry a can on your head, then you walk. Even […] Nowadays yes, when things have changed a lot, but when I was growing up I used to live in a village whereby you go and collect your water far away from home, then you carry the water on your head, then the distance would be longer. Even in the field, you go in the field, you help in everything. It's not like here when you are 12 years you don't know how to cook and do everything, but in African when you are 12 you are like a mother to other kids. Your mum, they will be going to the fields, you will be looking after the kids, you will cook for them, you will serve them, you do everything. You would help in bathing them. I think African children are physically… are more physically healthier than here. Because here they sit and the turn on the TV." *ID12, mother, Black African, country of birth: Zimbabwe, faith: Christian [parent quote]*

6.5.1.3.4 Logic model: Findings related to Black African and Caribbean groups

Figure 6.3 provides a figurative overview of the key findings for the Black African and Caribbean ethnic groups from across the four study components in relation to one another.

Figure 6.3. Logic model for findings for Black African and Caribbean groups



6.5.1.4 Findings related to the South Asian group

Illustrative quotes are provided in Table 6.5.

Key findings:

Weight status patterns dependent upon measure used: The NCMP analyses for South Asian children suggest two potential scenarios, dependent upon how adiposity is assessed. Part 1 and 2 of the analyses found heterogeneity within South Asian ethnic groups, with Indian children having low odds for ov/ob, whilst Bangladeshi and Pakistani children had high odds.

However, as with the Black African and Caribbean group, the interpretation of NCMP analyses is complicated by the potential for mis-estimation of adiposity in South Asian ethnic groups. When using Adj zBMI values (adjusted for fat mass), the nature of ethnic group differences changed, with a higher Adj zBMI across both age groups for all South Asian groups.

This mixed methods analysis therefore sought findings from studies 1, 3 and 4 that could provide potential explanations for both scenarios: 1) heterogeneity across Indian children (typically low levels of ov/ob) versus Pakistani and Bangladeshi children (typically high levels of ov/ob, at least for older children); and 2) a high Adj zBMI across all South Asian groups.

6.5.1.4.1 Thread 8: Ethnicity and culture (Scenario one)

This thread refers to the scenario in which ethnic groups patterns in childhood ov/ob are heterogeneous within the South Asian group.

Explanatory value: Mixed

Overall, there was very little difference apparent in the beliefs and experiences described by Indian, Bangladeshi and Pakistani parents and children, to the extent that findings have generally been described in previous chapters as attributable to the aggregated 'South Asian' ethnic grouping. However, due to the nature of within-group variation in odds of ov/ob observed in the NCMP analyses, sub-group analysis was retrospectively attempted as an additional step for the purposes of this mixed methods integration, and is summarised below. Children from Bangladeshi and Pakistani ethnic groups have been grouped together due to small numbers. It is important to note that some differences within the South Asian group appeared attached to faith and country of birth in particular.

Body size ideals/image: Indian children made greater reference to 'strength' in their definitions of health, whilst Bangladeshi/Pakistani children did not make reference to strength, indicating a potential preference for leaner body shapes. However, it is important to consider that the Bangladeshi/Pakistani group consisted mostly of girls, for whom 'strength' and 'muscle' had a lower importance in general.

Valuing of treats: Bangladeshi/Pakistani children mentioned a liking for sweets or chocolates, whilst no Indian children did, potentially contributing to unhealthy dietary practices for this group.

Religious commitments: Commitment to attend mosque was identified as barrier to physical activity, and appeared more often in the data of South Asian Muslim parents, regardless of ethnicity.

Cultural expectations/norms: Cultural norms around female exercise were also found in parents from Muslim backgrounds only, regardless of Indian or Pakistani ethnicity, and was apparent in UK-born parents only.

The systematic review also highlighted an additional potential contributory factor:

Socioeconomic position: In the systematic review, analyses tended to adjust for socioeconomic factors, with little bearing on the findings. However, in one study, a composite measure of SES (mother's employment, single parenthood, and socioeconomic position) explained the high odds for obesity in Bangladeshi children (Zilanawala *et al.*, 2015). Factors related to SES and deprivation, such as safety concerns, may therefore act as strong barriers to a healthy lifestyle in this group.

Data coherence:

Study 1: Partial agreement Findings from the systematic review echoed these results: Bangladeshi children in particular typically had a high prevalence of ov/ob (10.7% - 13% obese), whilst Indian children typically had a low prevalence of ov/ob (4.3% - 5% obese) (Brophy *et al.*, 2009; Kelly *et al.*, 2012; Smith *et al.*, 2012; Zilanawala *et al.*, 2015). However, findings in other South Asian groups, such as for Pakistani children, were largely inconsistent. In relation to the potential influence of SEP upon heterogeneity between South Asian groups, the NCMP analyses do not agree with findings from the systematic review in which SES explained high odds of obesity in Bangladeshi children. The NCMP analyses found that IMD did not account for the high odds for ov/ob observed in older Bangladeshi and Pakistani children. In addition, the NCMP analyses suggested an inverse gradient between deprivation and adiposity in Bangladeshi children (younger boys only), similar to the pattern seen in Black African boys, in which high deprivation was protective against ov/ob status. However, no individual or household measures were included in NCMP analyses, limiting exploration of this potential contributor.

Studies 3 and 4: Absent Sample differences across the two qualitative study components limited the ability to compare and contrast children's and parents responses, so agreement across these two study components is low.

6.5.1.4.2 Thread 9: Ethnicity and culture (Scenario two)

Scenario two proposes that children from all South Asian groups have a high Adj zBMI (i.e. after adjustments were made for fat mass).

Explanatory value: mixed

The qualitative data provide some potential explanation for the scenario in which children from South Asian groups have a high Adj zBMI.

Body size ideals/image: Firstly, when looking at children's data, few children from South Asian backgrounds interpreted a healthy body as a muscly and strong body vs White British, and South Asian children considered a low weight to be unhealthy.

For South Asian parents, a cultural valuing of a large body size, associated with healthfulness and indicative of being well-fed, was apparent in the data of South Asian participants. Parents from South Asian backgrounds in particular also discussed their parental preference for their own children to not be too slim or underweight e.g. *"a bit of fat on them, just baby fat"*. The qualitative data has therefore revealed a potential mechanism for understanding a high Adj zBMI in South Asian children: a preference for larger weight, driven by cultural ideals.

Dietary behaviours/beliefs: The qualitative data were mixed in reporting the relative healthfulness of traditional South Asian dishes. On the one hand, some South Asian parents considered traditional dietary practices as healthy e.g. chapattis, lentils, curry, use of spices, spinach. However, as with the Black African and Caribbean groups, some parents felt that children had a dislike for traditional foods, due to their spiciness, and a preference for 'British' foods, so it may be the case that children have a low consumption of a traditional diet due to this conflict.

Another apparent contradiction was that South Asian children more commonly described the negative effects of a high sugar intake compared to other groups, which would typically be considered as a protective behaviour against a high BMI. It should be noted that the majority of children doing so attended the same school, so this may be an artefact in the data. However, knowledge does not always determine behaviour (especially in children who make fewer independent food choices), so this view may not be strongly linked to risk of overweight.

However, some South Asian food was described as unhealthy e.g. frying, use of oil, white flour for chapattis and white rice. In addition, there was some resistance or cynicism from some South Asian parents to make healthy adaptations to traditional food practices, possibly due to the effort required in breaking from the norm e.g. *"we don't go looking for brown [rice]"* (see section 5.5.2.2.3). This may contribute to unhealthy dietary practices that lead to a high BMI for South Asian families.

Data coherence:

Study 1: Disagreement A high Adj zBMI across both age groups for all South Asian groups, as observed in NCMP analyses using fat mass-adjusted BMI values, is not supported by findings from the systematic review, in which the 'Asian'/'South Asian group generally had a lower prevalence of overweight and obesity compared to reference groups. However, this was only the case when using the aggregated grouping 'Asian'/'South Asian', whilst when disaggregated groups were used, there were large differences in prevalence within this group (as detailed in section 6.5.1.4.1). It is important to note that all studies in the systematic review reporting prevalence used BMI (unadjusted) alone, with the exception of one study (Henderson, 2010) (this study was with British Pakistani children and used BMI, SFT, WC and waist-height ratio), so this inconsistency with other literature is expected.

Studies 3 and 4: Absent In the current study, children rarely made reference to traditional foods. This lack of agreement with the parental study may be due to a lack of engagement with food practices in general (i.e. children are generally not involved in cooking), or may be indicative of the low importance of traditional foods for South Asian children. Children also did not explicitly discuss beliefs relating to a cultural valuing of overweight, in contrast with parents.

6.5.1.4.3 Thread 10: Age

Key finding:

Divergence in patterns of weight status across year groups for South Asian children (older children had high odds of ov/ob): High zBMI/odds for ov/ob in comparison to White British children was most apparent in *older* South Asian children. In these ethnic groups, children tended to have a low zBMI in early childhood, relative to the White British children, but a high zBMI/odds of ov/ob in later childhood. South Asian ethnic groups (especially Pakistani and Bangladeshi groups) saw the largest difference in zBMI and odds of ov/ob between reception and year 6 compared to other groups.

Explanatory value: explanatory

Focus on academic attainment in older children: One potential contributory factor was highlighted in the two qualitative study components. Both parents and children valued ‘learning’, with South Asian parents in particular describing prioritisation of academic commitments over being physically active. Since academic performance seemed to be a concern relating to *older children* specifically (see 6.5.1.2.1), the high valuing of academic performance (and consequent reduction in PAL) in the South Asian group may be partly responsible for particularly stark differences between younger and older children in this group. However, this finding must be interpreted cautiously since data were not collected on the age of participants’ children in the parent study, which could influence this finding.

Data coherence:

Study 1: Agreement The systematic review provided some support for a longitudinal effect (increases as South Asian children age). One study exploring longitudinal change in BMI from age three to seven found *steeper* increases in Asian children versus White children of British-born mothers, despite a lower BMI in South Asian children at age three (Martinson *et al.*, 2015). This was particularly the case for Asian children of British-born mothers, compared to those of mothers born abroad. The authors propose an early adiposity rebound in this group.

Studies 3 and 4: Partial agreement Both South Asian children and parents in the current study highlighted the importance of education, which was linked to older age from the perspectives of parents, but not from the perspectives of children (the child sample did not include older children).

6.5.1.4.4 Thread 11: Gender

Key findings:

Dimorphic weight status patterns by gender for South Asian children (boys had high odds for ov/ob): High odds of ov/ob was particularly the case for South Asian boys versus girls. For example, older Indian and Pakistani boys had significantly higher odds of ov/ob versus White British boys, whilst girls did not. Although older Bangladeshi girls and boys had high odds of ov/ob versus White British children, this was of a greater magnitude in boys, and only boys had a significantly higher zBMI in comparison to White British children.

Explanatory value: contradictory

There was little data from the two qualitative study components to suggest an underlying rationale for gender-based differences in weight status in South Asian children. Data from the parental study component suggest greater barriers to a healthy weight for girls over boys, which appears instinctively at odds with the NCMP findings. Example quotes from qualitative data are provided in Table 6.5.

Cultural expectations upon girls: South Asian mothers of Muslim faith talked about taboos relating to the perceived ability of girls and women to be physically active in public (see 5.5.2.2.4). The impact of cultural expectations and ideals may exert a more complex influence upon gender-based differences in weight. For example, despite apparent cultural taboos around physical exertion in females, this did not appear to impact on parental reports of physical activity for their own daughters, who were described as active and involved in sports/physical activity despite cultural expectations upon girls. It may be the case that cultural expectations exert a greater influence as girls transition to adolescence and young adulthood.

Body size ideals/image: Some mothers also spoke of a cultural valuing of a large body size that was particularly applicable to females, with one participant describing a cultural viewpoint that being slim reduces fertility. There may be some additional complexity to this issue: both mothers discussing this issue also mentioned girls' self-consciousness about weight. This appeared to emanate from a societal pressure relating to a focus on female appearance, suggesting competing demands upon girls from a South Asian traditional/cultural perspective and a British media/societal perspective, which may result in greater weight control behaviours.

Conflict with traditionally-held cultural expectations may therefore provide some explanation for why South Asian girls do not appear at high risk for overweight compared to South Asian boys, despite these cultural influences.

Although this discussion has identified potential reasons for why girls are not at a high risk of excess weight, the data are silent in elucidating potential explanations for why South Asian boys in particular may have a high risk for excess weight.

Data coherence:

Study 1: Partial agreement In the systematic review, identification of differences in weight status across boys and girls was limited to Pakistani children only. One study (Henderson, 2010) explored prevalence of excess weight (overweight) in British Pakistani children and found that boys had a higher prevalence of excess weight vs White British boys (39% versus 29.9% using UK90 cut-offs) whilst British Pakistani girls had a lower prevalence vs White British girls (24.4% vs 36.2%), suggesting some agreement with the current NCMP analyses.

Studies 3 and 4: Absent Gender-based differences were not apparent in data emerging from the child qualitative study, although this may be due to low numbers prohibiting any analysis based on the intersectionality of ethnicity and gender.

Table 6.5 Example quotes from qualitative data: mixed methods findings for South Asian ethnic groups

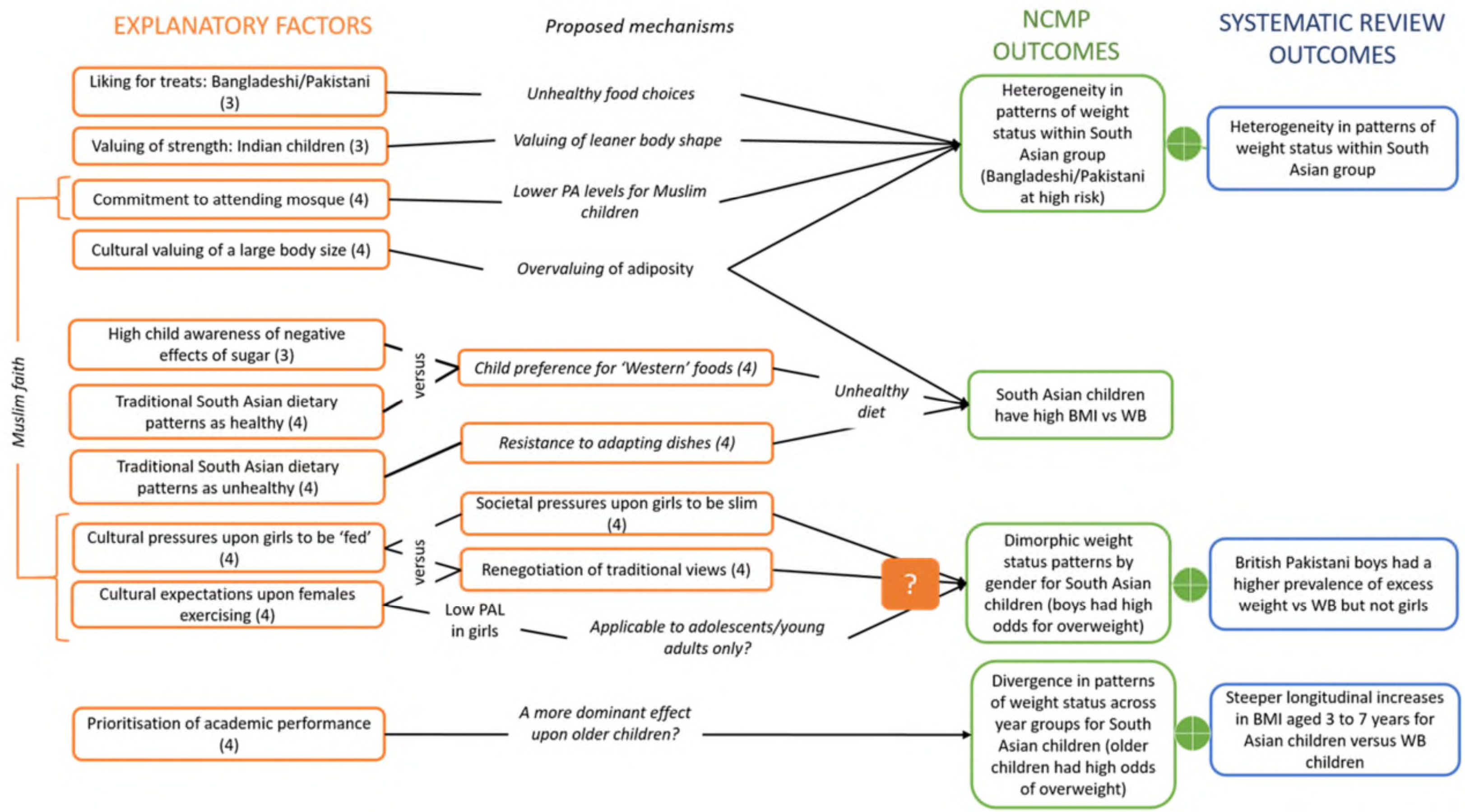
Thread	Illustrative quotes
Ethnicity and culture (scenario one)	Interviewer: "And what kind of body do you think this [healthy] child has compared to other children?" ID7: "A very strong body but compared to others, some are skinny, some are a little bit more fatter, and yeah." Interviewer: "And so what does a strong body look like?" ID7: "It's not always about muscles and all of that, it's about what you do and how do you do it. So you can be whatever you like, but to be strong you have to do the things of exercising and eating healthy." *ID7, boy, Indian ethnicity, UK born, 2 parents born abroad [child quote]*
Ethnicity and culture (scenario two)	"Oh yeah, she [the healthy child] isn't too skinny, like staying fat, she doesn't eat much then she isn't like… I don't want to say fat, but she isn't… she doesn't weigh more than she needs to. So she's just about average" *ID20, girl, Bangladeshi ethnicity, UK born, 2 parents born abroad [child quote]* "Because if they're [children] too skinny and they're weak, and then they'll moan their bone hurts, or so and so hurts…" *ID27, mother, British Muslim, country of birth: UK, faith: Muslim [parent quote]* "As a family, obviously coming from an Asian family, we always have, every day, it's like chapattis and some sort of a different curry. It can be like a chicken curry, lentils. But when it's like, for dinner on a Saturday and Sunday, we tend to have some fish and chips, or any like, I would say like kid's choice of food. Like if they want wraps, chicken wraps, pasta, I'll do that." *ID23, mother, Pakistani, country of birth: UK, faith: Muslim [parent quote]* "…sometimes you have like a sugar meltdown. I think it was called that when you have too much sugar and the sugar… you've got a sugar rush and then it all melts down and then you like feel a bit drowsy." *ID24, girl, Mixed ethnicity (White British and Asian Indian), UK born, 1 parent born abroad [child quote]*
Age	Interviewer: "And then when children do have homework and things, do you, would you prefer them to be doing physical activity, or do you prefer them to be doing homework? How do you balance?" ID30: "To do the homework first. Education comes first" ID29: "Yes, education first." ID25: "Education" *ID30 mother, Asian Indian, country of birth: UK, faith: Muslim; ID29, mother, British Muslim, country of birth: UK, faith: Muslim; ID25, Muslim, country of birth: Pakistan, faith: Muslim [parent quote]* "… if you don't sleep a lot your brain won't work properly because you need to sleep so your brain will activate" *ID27, boy, Bangladeshi ethnicity, UK born, 2 parents born abroad [child quote]*

Thread	Illustrative quotes
Gender	ID30: "And what my parents did… you know my mum wouldn't dream of running, so I'm the same, I'm thinking 'god I wouldn't think of doing that', whereas my kids I'd probably try and encourage it. But then I think other people will be judgemental of that so that might stop me from letting her [my daughter]" Interviewer: "By other people do you mean the community or the family?" ID30: "Yeah the community, the community, the community" *ID30, mother, Asian Indian, country of birth: UK, faith: Muslim [parent quote]* "…from my Asian culture point of view as well, I do feel that when my daughter wants to play outside, I'm a bit 'shall I let her?', I'm really worried about her. Whereas maybe, if it was my son, he does sometimes, will go and play, I'm not that worried about him. I don't know, it's just that… maybe it's just that girl thing that you're more worried about, like their dignity sort of side as well to it." *ID23, mother, Pakistani, country of birth: UK, faith: Muslim [parent quote]* ID26: "My auntie comes from Birmingham, she says 'listen you feed up the boys, why not feed up the girls?' I say give me food for XXX, I never give boys more and girls less, all the time I give all my children the same food" ID24: "The same portion right?" ID26: "But the girls say 'mum we're fine, we don't want to get fat'" [Laughs] *ID26, mother, British Muslim, country of birth: Pakistan, faith: Muslim; ID24, mother, Asian Indian, country of birth: UK, faith: Muslim [parent quote]* "…this girl is underweight and she doesn't like eating because like she's scared to gain weight because she doesn't want to be fat when really she's not even the average weight." *ID20, girl, Bangladeshi ethnicity, UK born, 2 parents born abroad [child quote]* "I think with girls it's more, I think it becomes like a competition with their peers as well, the way you look and how your body is. Whereas boys, they don't bother really in that sense. And I think sometimes it's the media as well, like the celebrities as well, and the magazines, and in the news. You'll hear stories like girls losing weight, or a celebrity lost this much weight after having a baby, doesn't seem like she had a baby. And that does actually, I think, quite affects a lot of girls, not just the girls, I think it's the women as well. It affects them as well in that sense that people, if you've got a lovely figure then everybody says 'wow'. And if you haven't got a lovely figure then obviously it just, I think people, it affects their confidence in that way as well." *ID23, mother, Pakistani, country of birth: UK, faith: Muslim [parent quote]*

6.5.1.4.5 Logic model: Findings related to South Asian ethnic groups

Figure 6.4 provides a figurative overview of the key findings for the South Asian ethnic groups from across the four study components in relation to one another.

Figure 6.4. Logic model for mixed methods findings for South Asian groups



6.5.2 Assessment of integration fit

Each 'thread' was assessed for 'explanatory value' and 'coherence' of data across study components. Table 6.6 provides an overview of codes applied to data within themes. Data from study components 1, 3 and 4 generally provided explanatory value for the key findings from study component 2, with some providing contradictory data and some providing a mixture of the two. Data within each thread generally showed partial agreement or absence (i.e. findings were only applicable to one study component, and were absent from others). Potential mechanisms of action and pathways are discussed in more detail below.

Table 6.6 Results of assessment of integration fit

Codes	Number of codes assigned
Explanatory value codes (total)	**11**
Explanatory	7
Contradictory	2
Mixed	2
Data coherence codes (total)	**22**
Agreement	5
Partial agreement	7
Disagreement	2
Absent	8

6.6 Discussion

6.6.1 Key findings and comparison to other literature

The first aim of this mixed methods analytical integration was to understand the extent to which the findings from study component 2 were explained by the other study components. In this section, the key findings from study component 2 are discussed in relation to those from the other study components.

6.6.1.1 Universally-applicable findings

For universal findings, findings from study components 1, 3 and 4 were generally explanatory, and were also supported by existing literature, for example, increased risk of adiposity over the life course (Emmett & Jones, 2015), higher prevalence of overweight and obesity in boys versus girls, at least up until adolescence (Conolly, 2016; Fitzsimons & Pongiglione, 2017) and a positive association between deprivation and weight status (El-Sayed *et al.*, 2012; Noonan *et al.*, 2016b; Townsend *et al.*, 2012).

A surprising finding in the mixed methods analysis was the lack of complementarity in findings around the role of the school. In NCMP analyses, the extent to which schools varied in zBMI was small, with much of the variation observed at the individual level. Despite this lack of school contribution in the quantitative data, the qualitative data showed that children and parents strongly favoured the role of the school in helping to support healthy behaviours and prevent childhood obesity. The low variation in zBMI across schools does not necessarily suggest that schools do not play a role in tackling childhood obesity, but rather suggests a minimal role of schools in explaining variation in overweight: it may be that there is a ceiling effect in the role of schools (i.e. that they can only influence childhood BMI to a certain extent); or it may be that primary schools (particularly in Coventry) vary little in their health promoting offer. With the existence of school food standards, government-recommendations for PE, the Healthy Schools programme and local school health promotion initiatives, all implemented over the course of the period studied, schools may have been too similar in their 'health provision' to impact upon prevalence of overweight. It may also be the case that individual-level influences, as well as additional levels of influence not explored, such as family- or household-level influences, exert such a strong influence that the school influence is minimal in comparison (discussed in Chapter 3).

Another key finding from the mixed methods analysis was the mixed findings in relation to the role of neighbourhood access to green space/leisure facilities and car ownership. The existing literature shows distance from neighborhood physical activity facilities to be negatively correlated with child physical activity levels and access to parks, playgrounds and open space to be positively correlated (Carlin *et al.*, 2017), in support of the findings in the current study. The current qualitative findings suggest that the lack of access to a car (a component of area deprivation in some measures) inhibits travel to leisure facilities, with public transport viewed as a burden (that further compounds the mental effort required to visit a leisure centre), and so car ownership may mediate the relationship between distance to leisure facilities and physical activity. On the other hand, parents and children also reported that a lack of personal transport resulted in a greater reliance on walking, which would contrastingly result in high physical activity levels and lowered adiposity for those from deprived areas. Neighbourhood deprivation may again play a role in this relationship, for example, concerns about safety and a poor quality local environment may result in families undertaking walking for essential journeys only, such as the school commute, which may not contribute adequately to reducing risk of adiposity (Faulkner *et al.*, 2009).

6.6.1.2 Black African and Caribbean ethnic groups

One finding that was consistent across all study components was the potential role of 'treats'. Other studies have found high consumption of sweets, sugary drinks and sugar intake from cakes amongst migrant adolescents in Europe (Kumar *et al.*, 2004), so ethnic background ('African life') and migration status ('British life') may interact in this case. For example, the high use of treat foods may be linked to a belief in African cultures associating both large weight and 'Western' foods with wealth and status (i.e. fast food in Africa is *"for the rich"*), which may emerge from historical experiences of food insecurity (Kumanyika *et al.*, 2012). In terms of migration, a small number of parents described how moving from an environment of relative hardship and food scarcity to one of perceived comfort and abundance had resulted in unhealthy behaviours (e.g. *"before came here all I said was like, when I get to England I want to eat loads and loads of chocolate and sweets"* – see section 5.5.2.3.1). This preferential consumption of calorific/high status food may even persist in future generations via what has been described by Kumanyika *et al.* (2012) as 'deeply embedded cultural memory'. Blissett and Bennett (2013) also considered that higher responsivity to environmental food cues may contribute to high 'food approach' levels for Black African and Caribbean families. This increased responsivity may also relate to a high valuing of treat foods (high valuing of treat foods may increase propensity to food purchasing, especially when in an environment where such foods are abundant), and may pose as a potential mechanism underlying increased intakes of 'treat foods'. This is an example of a cultural-contextual interaction (Kumanyika *et al.*, 2012), in which African cultural beliefs interact with UK context to generate an obesogenic behaviour. In African environments, this cultural belief was not harmful due to the low availability and expense of 'treat foods', and the high levels of physical activity obtained from social and community ties. Although 'treat foods' are cheap and available to all in the UK, it is the additional contribution of the 'status' given to treat foods that may generate an especially harmful environment for African migrants.

Previous studies have, similarly to this study, partly attributed high risk of adiposity in Black African and Caribbean groups to sociocultural traditions and beliefs, with clear mechanisms underlying their association with adiposity. For example, low levels of concern for child overweight status in some African groups (Brophy *et al.*, 2009; Department of Health, 2008; Trigwell *et al.*, 2014), which may be partly driven by a cultural valuing of large body size (Toselli *et al.*, 2016; Tovée *et al.*, 2006) and subsequent lack of recognition of child overweight status (Falconer *et al.*, 2014b); and the cultural importance of food in relation to hospitality for African groups, which may contribute to the consumption of energy dense social/'high status' foods (since hospitality is often seen as an opportunity to demonstrate wealth) (Nicolaou *et al.*, 2012; Nicolaou *et al.*, 2009; Osei-Kwasi *et al.*, 2016; Osei-Kwasi *et al.*, 2017).

The potential role of SEP was complex in the findings reported here, and requires further consideration from the literature. The NCMP analyses found that high deprivation was not associated with high adiposity in younger Black African boys. The symbolic nature of a large body size in demonstrating success and wealth is reported elsewhere (Kumanyika, 2008; Lucas *et al.*, 2013; Mvo, 1999; Tovée *et al.*, 2006; Wells, 2009). Reviews of socioeconomic relationships with weight status within developing or low-middle income countries offer further support for a symbolic valuing of a large body size, in which high income, high education and high SES were associated with highest levels of obesity, present in both adult and child populations (Dinsa *et al.*, 2012; Fruhstorfer *et al.*, 2016; Kinge *et al.*, 2015). These beliefs may be so culturally embedded that the relationships persist in migratory populations in the new environment.

In addition to cultural beliefs around weight and success, the qualitative data suggest that in African countries, obesogenic behaviours may be accessible only to those from high socioeconomic backgrounds, whilst obesity-protective behaviours appeared related to a lack of material wealth e.g. food scarcity, walking long distances/lack of access to a car, physically-demanding household chores and having to grow your own food, further linking large body size is to wealth and success.

Both of these scenarios would contribute to the presence of positive socioeconomic gradients in health for those from Black African and Caribbean backgrounds, as observed in the NCMP analyses and systematic review (i.e. high IMD/income/education/class, high risk of ov/ob). The overall picture is one of a positive relationship between socioeconomic measures and child weight status, measured across both individual and neighbourhood domains.

This mixed methods analysis identified some additional complexity in the relationship between socioeconomic status and ethnicity. Parents described a number of 'transitions' in beliefs that could be partly related to the experience of migration, and acculturation towards a British way of life. This includes shifting body size ideals (Toselli *et al.*, 2016; Tovée *et al.*, 2006); dietary transitions following migration, largely based on economic capacity; and a lessening of the physical demands of life, due to greater access to material goods. Shifts towards lower levels of physical activity were also related to low SEP within a UK context e.g. unaffordable indoor leisure activities/clubs. Although 'acculturation' is expected to some extent for all migrant groups in their host country (Satia-Abouta, 2010), the qualitative findings suggest that one would expect to see large shifts in obesity-related beliefs and behaviours (from healthy practices to unhealthy ones) in *lower income groups* in particular migrating from Africa to the UK.

A substantial body of research has found country-level 'transitions' in socioeconomic gradients in obesity related to stage of development and wealth (Dinsa *et al.*, 2012; McLaren, 2007), with dynamic shifts in socioeconomic gradients as countries transition from low, to middle to high stages of development (Monteiro *et al.*, 2004). This phenomenon was dubbed the 'nutrition transition', driven by 'technological clashes with human biology' (Popkin *et al.*, 2012). However, this mixed methods analysis proposes that the socioeconomic 'nutrition transition' occurs at an individual-level also, upon migration from a low/middle income country to a high income country. Such a transition has been proposed in systematic reviews of quantitative studies with adults (Alidu & Grunfeld, 2017; Delavari *et al.*, 2013). However the current study uses qualitative data to identify acculturative processes following migration, especially those applicable to families and children.

If this hypothesis were true, we would expect to see a difference in socioeconomic relationships in health depending upon migrant status and length of time in the UK, and the systematic review finds some support for this case, with a positive socioeconomic gradient observed for income in children of foreign-born Black parents only (Martinson *et al.*, 2012). On the other hand, the same study found a protective effect of low education in Black children of UK-born mothers only (Martinson *et al.*, 2012), potentially contradicting this hypothesis. In the current qualitative study, there were no UK-born parents of African backgrounds in the study sample to make comparisons of parental beliefs and experiences on the basis of country of birth to further explore this idea.

Acculturative effects are likely to be complex. For example, some authors theorise lower levels of acculturation in low income and less educated migrant groups, offering some protection against obesity-related behaviours (Satia-Abouta, 2003). However, data from the parental qualitative study suggest that 'acculturative stress' may be greater in low income migrant groups, due to a higher number of stressors (e.g.

material disadvantage and limited access to traditional foods) (Alidu & Grunfeld, 2017). Acculturative effects may differ across generations within the same family, for example, migrant children from across all SEP groups will have relatively high exposure to the host culture through attendance at school, even where parents do not (van Hook & Baker, 2010), so using parental markers of SEP may not provide the full picture. In summary, acculturation following migration may have differential effects across socioeconomic strata (Van Hook & Stamper Balistreri, 2007).

6.6.1.3 South Asian groups

The existing literature supports some of the key findings identified within the South Asian groups, and proposes some potential mechanisms. This includes a preference for larger weight, driven by cultural ideals (Murphy *et al.*, 2017); the importance attached to group norms in relation to food and eating practices (Lucas *et al.*, 2013), which may contribute to unhealthy dietary practices for South Asian families; a decline in maintenance of a traditional South Asian diet across generations, linked in the literature to decreased fruit and vegetable consumption (Uskul & Platt, 2014); and the prioritisation of academic performance, which may act as a barrier to physical activity for older South Asian children (Trigwell *et al.*, 2015).

However, the qualitative data did not support the NCMP findings in some cases, requiring further exploration of the potential underlying pathways relating beliefs and behaviours to adiposity in this group. The qualitative study components provided limited explanation for heterogeneity in child adiposity across Indian, Pakistani and Bangladeshi families. This may be partly related to the complex contributions of ethnicity, faith, acculturation and SEP within the South Asian group. Trigwell *et al.* (2015) identified Muslim faith as the key component contributing to the identification of a lack of culturally appropriate PA opportunities as a barrier for girls, affecting Bangladeshi, Somali and Yemeni families. Other authors have described difficulty in deconstructing the relative influence of religion, ethnicity and acculturation upon the health beliefs of Pakistanis (Ludwig *et al.*, 2011). There are also established differences in socioeconomic profiles for Indian, Pakistani and Bangladeshi groups in the UK which may partly explain ethnic group differences within the South Asian group (Bhopal *et al.*, 1999; Bhopal, 2014; Nazroo *et al.*, 2006; Zilanawala *et al.*, 2015), and one study in the systematic review found that socioeconomic status explained the high odds for obesity in Bangladeshi children (Zilanawala *et al.*, 2015). Although the NCMP analyses here adjusted for IMD, no individual or household measures were included in analyses, limiting exploration of this potential contributor. Differences in migratory status may also contribute: both Pakistani and Bangladeshi children tended to have parents who are first generation migrants (Zilanawala *et al.*, 2015), so the contribution of migration and acculturative stress to childhood obesity may be a factor for these groups (El-Sayed *et al.*, 2011). Mu'Min Chowdhury *et al.* (2000) found low levels of dietary acculturation in Bangladeshi migrants (typically protective against obesity), however, the researchers did find that dietary patterns shifted towards an increase in 'special menu' traditional foods which were typically more energy dense (e.g. biryanis), due to their greater affordability and abundance of ingredients, following migration.

Overall however, the presence of qualitative research that aims to compare the views of Indian, Pakistani or Bangladeshi groups in relation to diet, physical activity and childhood obesity is limited.

There was also little data from the two qualitative study components to provide potential explanations for gender-based differences in weight status in South Asian children. The existing literature is similarly unclear in theorising potential pathways. For example, researchers have found low levels of physical activity in South Asian girls in particular (Bhatnagar *et al.*, 2016; Leung & Stanner, 2011), although changes in attitudes towards physical activity in second-generation South Asian women have been observed in the current study and elsewhere (Bhatnagar *et al.*, 2016). However, studies have found less healthy dietary habits in South Asian boys (Leung & Stanner, 2011), possibly due to greater indulgence and permissiveness for boys with parents born abroad (van Hook & Baker, 2010).

6.6.2 Coherence of integration

An additional aim for this chapter was to assess the 'fit' of the integration and address any inconsistencies in data. This mixed methods analysis has highlighted the extent to which qualitative data in particular can contribute meaningfully to understanding ethnic group differences in childhood weight status. In many cases, the qualitative data provided a useful exploration of the potential pathways and underlying mechanisms contributing to childhood overweight e.g. high zBMI and odds of ov/ob in Black African and Caribbean children. The key benefit proposed from this mixed methods integration at the analysis stage is the depth that the qualitative findings added to the quantitative findings. This is exemplified in findings related to the influence of SEP in Black African and Caribbean ethnic groups, in which parents verbalised cultural, dietary and physical activity beliefs and behaviours which helped to explain the potentially protective effect of low SEP in African contexts, but also eluded to the transitional nature of these beliefs and behaviours following migration. The addition of parents' stories added a new dimension to imagining the effect of migration to the UK upon these beliefs and behaviours.

On the other hand, in some cases, the qualitative data appeared seemingly at odds with the quantitative findings e.g. gender differences in weight status in South Asian groups. Although this inconsistency and conflict within the mixed methods analysis could be interpreted as weakening the validity of overall findings, mixed methods researchers offer an alternative view. Conflict is seen as both expected and enriching within mixed methods research, providing an opportunity to better understand the complexity and multidimensionality of the research topic (Bazeley, 2018; Brannen, 1992; O'Cathain *et al.*, 2007; Patton, 1990; Woolley, 2009). Described as "inter-method discrepancy" (Fielding & Fielding, 1986), these contradictions are viewed as a starting point for theorising alternative explanations of complex phenomena, and for exploring the ways in which findings are a manifestation of the methodological approach (Fetters *et al.*, 2013).

An example of this is the exploration of heterogeneity in adiposity across Indian, Pakistani and Bangladeshi groups. Due to sampling issues in the two qualitative studies, there was little opportunity for understanding divergence across Indian vs Pakistani and Bangladeshi groups. In addition, sample differences across the two qualitative studies limited the ability to compare and contrast children's and parents' responses, so agreement across study components is low. For example, in the child study, only one child with a Pakistani background participated, whilst in the parent study there were no participants who described themselves as Bangladeshi. Within the systematic review, studies tended to use the aggregated 'South Asian' grouping, also hampering understanding of variance within this group.

One key finding relating to the coherence of integration is the large absence of data 'threads' across all study components, i.e. themes emerging in parental reports were often absent from child reports. This was generally the case for sociocultural beliefs specific to ethnic groups in particular e.g. cultural valuing of weight; the role of traditional foods; taboos around physical activity in girls. There are several possible reasons for this discrepancy. The first is a genuine difference in the cultural valuing of weight between parents and children: this may be due to a low awareness or low importance of prevailing ethnicity-based traditional body size ideals for children, and may suggest low generational transmission of body size beliefs amongst African families in Coventry (although parents and children in the current study were not recruited from the same families). The majority of Black African children in the current study were born in the UK, so may be more attuned to Western society's body size ideals, which could over-ride traditional culturally-based beliefs. On the other hand, contrasting findings may be the result of methodological differences in data collection, hence are potentially an indication of a lack of validity in the findings from the child qualitative study. For example, use of focus groups with parents may have facilitated greater identification of ethnic group-specific experiences.

It was also apparent from the current study that the qualitative data were not able to fully explain the quantitative findings. Full exploration required accessing the existing literature to elucidate potential underlying mechanisms linking qualitative data to quantitative data and in seeking potential alternative explanations. Bazeley (2018) suggests that this is also part of the process of integration: *"A picture is not always composed in one sitting – insights from other literature also become part of the mix"* (Bazeley, 2018 p.95). In this way, this mixed methods analysis did not necessarily establish the 'truth' in combining findings, but rather provoked further discussion and investigation (Fitzpatrick, 2016).

6.6.3 Appraisal of integration method

A final aim was to design and appraise an integration method for systematically integrating qualitative and quantitative findings. Analytical integration aims to enhance the value of mixed methods research by providing a more comprehensive picture of the research issue above and beyond insights gained from each study component alone (Fetters *et al.*, 2013; Guetterman *et al.*, 2015). In particular, this analysis aimed to *systematically* integrate mixed methods findings, and in doing so has prompted dialogue about the methods and acknowledgement of potential methodological weaknesses (Fielding, 2012), and a greater 'yield' than would be achieved without this systematic approach (O'Cathain *et al.*, 2007).

6.6.3.1 Strengths and limitations of integration

It is important to acknowledge the strengths and weaknesses of the analytical approach. Firstly, although the analytical process was outlined prior to undertaking analysis, in reality, a flexible, iterative approach was required. This has also been observed by other mixed methods researchers (Woolley, 2009).

Secondly, the labels generated within the two integration codes ('explanatory value' and 'data coherence') were generated partly based on existing approaches (Bazeley, 2018; Fitzpatrick, 2016) and partly on descriptions emerging from the data. The design of new labels was required mainly due to a lack of existing approaches that assess data coherence or convergence in an explanatory sequential design. On this basis, they may be highly applicable to the current study but may not have high replicability for other research. However, Fitzpatrick (2016) encourages researchers to find other labels that better describe the relationship between both forms of data in their own studies.

In addition, the use of working joint display tables to support synthesis of the data, the selection of data through 'following a thread' (and discarding of other data), and the integration codes used for triangulation of findings may be an oversimplification of the convergence occurring across study components, and in some cases may force together data which in reality is incompatible. However, each of these techniques allowed for a large quantity of data to be summarised in a succinct way (Fitzpatrick, 2016).

One additional point to note is that some key findings from study component 2 (NCMP analyses) were considered uncertain, yet their consideration and summarisation within the mixed methods integration may give these findings undue weight and lose some sense of their uncertainty. This is demonstrated well when considering socioeconomic gradients in child weight status within the Black African and Caribbean group. The mixed methods analysis reported a positive association between IMD and weight status, and a wealth of qualitative data were proposed in explanation. Yet this finding was only apparent in younger Black African boys, and the introduction of this interaction term did not vastly improve model fit. Fitzpatrick (2016) proposes appending data convergence labels with additional labels indicating the degree of variance involved in responses, and a similar approach could have been used in this case.

Finally, some researchers may argue that this type of approach to analytical integration is inappropriate in an explanatory sequential design, where the main points of convergence are at the sampling and data collection stage. This analysis however shows how analytical integration (through a combination of following a thread, joint display and triangulation) can be used within a sequential design to systematically identify and conceptualise how findings from latter stages help to explain findings from the early phases (Bazeley, 2018).

6.6.4 Implications

Through explicitly outlining the mixed methods integration process, this analysis is in-keeping with recommendations made by Guetterman *et al.* (2015) in labelling quantitative and qualitative results, being consistent with the design and the integration approach, and identifying inferences or insights generated. By describing and reporting the way in which this mixed methods analytical integration has been conducted, this analysis also contributes to the small but growing literature base on research processes and techniques by which genuine integration is achieved (Woolley, 2009), in particular analytical integration within an explanatory sequential design. This study suggests that combining several techniques was possible and valuable. Following a thread technique suited the sequential, explanatory design of the study, whilst the working joint display tables supported the organisation of data to support synthesis, and the triangulation protocol helped to make sense of the extent of convergence and discordance in the findings, and possible reasons for this. Although the integration method used was designed specifically for the purposes of this study, it draws on analytical approaches described by Johnson et al. (2017) and Fitzpatrick (2016). This emphasises the ways in which transparent descriptions of analytical methods can contribute to the evidence base and to future research.

6.6.5 Remaining gaps in the research

A number of gaps remain in understanding the determinants of childhood obesity, particularly in those from Black African and Caribbean and South Asian groups in the UK.

Firstly, in terms of universal findings, there is a need to further understand the role of schools in contributing to childhood overweight, in particular making comparisons between schools at extreme ends of the spectrum in terms of their health promoting offer.

For the Black African and Caribbean ethnic group, a priority for future research is to establish the appropriateness of diagnostic criteria for assessing weight status in Black children (as identified in Chapter 3). Once an accurate understanding of Black African and Caribbean children's risk of overweight is achieved, the relative importance of these protective and harmful beliefs, behaviours and relationships will become clearer. In particular, the potential positive relationship between socioeconomic measures and child weight status in this group requires further support (as identified in Chapter 2). The relationships between SEP and acculturation and their influence upon the 'nutrition transition' following migration in relation to childhood obesity should be an additional avenue for exploration (Alidu & Grunfeld, 2017; Delavari *et al.*, 2013) and future studies should strongly consider including a measure of migratory history, acculturation and/or length of stay in the UK to further unpick the relationship, through both quantitative and qualitative exploration. There is also a need to explore cultural valuing of weight status across generations within African families.

For the South Asian ethnic group, the current study suggests that the presence of qualitative research that aims to compare the views of Indian, Pakistani or Bangladeshi groups in relation to diet, physical activity and childhood obesity is limited. This emphasises the importance of qualitative research that actively seeks to understand within-group variation in beliefs and experiences of South Asian ethnic groups, and those that relate to faith and country-of-birth as a component of ethnicity.

6.7 Conclusions

This mixed methods analytical integration highlighted the ways in which the findings from study components 1, 3 and 4 provided potential explanations for the quantitative findings generated from study component 2 (NCMP analyses). This integration was most effective where the qualitative data provided accounts which demonstrated potential pathways underlying relationships between ethnicity and child overweight. Key findings included the identification of a cultural-contextual interaction between African life and British life following migration, which may contribute to increased adiposity and positive socioeconomic gradients in adiposity within Black African groups in particular; and illumination of the ways in which neighbourhood deprivation acts upon family life to increase adiposity. The integration also highlighted discrepancies and absences in the data, which represent areas for further research, such as heterogeneity in child weight status across Indian, Pakistani and Bangladeshi groups, and gender differences in weight status in South Asian groups. A systematic analytical approach consisting of following thread, synthesis through joint display, and assessment of integration fit enabled the synthesis of a large volume of disparate data into a coherent framework. In particular, the process enabled consideration of complex and multidimensional pathways underlying relationships between ethnicity and adiposity, and dialogue regarding the methodological basis for discrepancies in data, enabling a more comprehensive overview than analysis of study components in isolation. Through describing the analytical approach used, this analysis contributes to a small but growing methodological literature base illustrating mixed methods analytical integration.

6.8 Chapter summary

This chapter sought to bring together the findings from across all four study components in order to integrate and summarise findings in a meaningful way. The analysis has gone some way to meeting its primary aim of seeking explanation for the quantitative findings identified in study component 2 (NCMP analyses) via identification of convergence with the other study components, particularly the qualitative study components. The analysis has also been effective in assessing 'integration fit', the purpose of which was to identify and address any inconsistencies in data across all four study components.

Chapter 7 Discussion

7.1 Chapter outline

This final chapter provides a summary of key findings, and considers the extent to which these findings fill the current gaps in the literature. The chapter also provides a commentary on how the findings integrate with existing ecological systems theory, and considers how the findings can be applied to intervention and service design. A reflection on the quality of the research conducted in this thesis is also provided, along with a summary of the remaining gaps in the literature. Finally, in conclusion, this chapter considers the unique contribution made by this research.

7.2 Key findings

The literature review in Chapter 1 highlighted a number of gaps in the existing literature, and this mixed methods study has gone someway to filling these gaps, as detailed below. To provide an overview, the key findings from the four study components and the mixed methods integration are also detailed in Table 7.1.

7.2.1 Addressing gaps in the literature

7.2.1.1 Ethnic groups at high risk for overweight and obesity

The NCMP analyses highlighted that children from Black African groups were at particular risk of adiposity across childhood, and children from Black Caribbean, other Black groups, Bangladeshi and Pakistani groups were at risk in later childhood. Importantly, there were sex-based differences in ethnic group patterns, with girls from Black groups at particular risk, and boys from South Asian, Black African, White other and mixed ethnic backgrounds at high risk for adiposity in later childhood.

7.2.1.2 Appropriateness of metrics of childhood adiposity across ethnic groups

The NCMP analyses also highlighted that use of unadjusted BMI values in children may disguise true ethnic group disparities in child adiposity. Use of BMI values adjusted for fat mass and adjustment for the effect of height upon BMI suggests that Black children may in reality have lower adiposity than White British children, and that South Asian children may have higher adiposity, results which are generally oppositional to findings using unadjusted BMI.

7.2.1.3 The role of socioeconomic position in the relationship between ethnicity and adiposity

Findings from the NCMP analyses show that socioeconomic position does not typically explain ethnic group differences in adiposity (this was only the case for Pakistani girls). Findings from both the systematic review and NCMP analyses suggest that the influence of markers of socioeconomic position upon adiposity may differ across ethnic groups. For example, the established positive gradient between neighbourhood IMD and weight status (high adiposity in children from areas with high deprivation) may operate in the reverse for children from Black and Bangladeshi ethnic groups. There is however an influence of country of birth (foreign-born versus native-born) upon this relationship which remains unclear.

7.2.1.4 Contributors to childhood adiposity and differences in contributors across ethnic groups

Through the systematic review, and particularly through qualitative exploration, the research highlighted a number of universal factors that influence childhood adiposity, including concerns and restrictions upon children's physical activity levels, the struggle to achieve the 'healthy family' ideal, and the overwhelming influence of modern life. These barriers were largely a result of parents' notions of health which were driven by nostalgia for parent's childhoods. Parents valued the role of schools, family, community and government upon supporting family health behaviours.

The research also highlighted a number of cultural and contextual factors that may contribute to ethnic group differences in child adiposity. This includes the symbolic nature of body size for African and South Asian groups, the role of food in retaining cultural heritage for African families, the influence of gendered notions of dignity upon physical activity for girls from South Asian groups, restrictive parenting approaches in Black African and Caribbean families, and transitions in culturally-linked behaviours and beliefs following migration and generational shifts over time. In particular, a cultural-contextual interaction between African life and UK life may drive increased risk for adiposity following migration, whereby healthy traditional diet and physical activity practices are unmanageable to maintain in the UK context, where a culture of poor work-life balance, overwhelming availability of energy dense foods, perceptions of societal dangers and a lack of a sense of community drive transitions from healthy to unhealthy obesity-related behaviours. These transitions may be particularly influential for migrating African families from low socioeconomic backgrounds, where the symbolic nature of a large body size and 'Western' foods as indicators of wealth come face-to-face with an obesogenic environment in which these previously symbolic foods are abundant and cheap, in a society in which obesity is directly linked with poverty. The mixed methods analytical integration showed how these influences may contribute towards ethnic group differences in adiposity, and the complex relationship between socioeconomic position and adiposity in Black ethnic groups.

7.2.1.5 Children's perspectives on obesity and its determinants

The research also used child-centred methods to privilege children's perspectives, and found that children were motivated to be healthy, rationalised healthy choices despite the habitual and desirable nature of unhealthy behaviours, and viewed themselves as 'agents of change'. This was reinforced by parents who highlighted the often positive role of 'pester power' upon family health behaviours, rather than purely viewing children as negative influences upon attempts to improve family health. Children also highlighted the valued roles of parents, friends and schools, which represent potential key agents for intervention efforts. The privileging of the child perspective also revealed worrying beliefs related to children's perceptions of obesity and the attribution of undervalued personal characteristics to the 'obese child'. These perspectives may allow children to distance themselves from the reality and ubiquity of childhood obesity in the population, and has implications for the social stigmatisation of overweight children. The mixed methods analysis also highlighted how gendered body size ideals e.g. social pressures upon girls to be slim, may contribute to the higher adiposity observed in boys (but is also likely to be emotionally damaging for girls).

The collection of children's perspectives focused on those from schools in deprived areas, and from a broad range of ethnic groups, in order to address a major gap in the literature. This research highlighted a small number of themes related to socioeconomic position and ethnicity, but the majority of themes were universal. This finding was considered to potentially be the result of high resilience to material disadvantage in children, and low levels of identification with ethnicity in this age group.

7.2.1.6 Application of socioecological models across ethnic groups and enhancement of local intervention design

Additional gaps in the literature relate to the applicability of existing socioecological models of obesity for conceptualising the determinants of childhood obesity for those from minority ethnic groups, and application of knowledge of local population-specific characteristics and contexts to intervention development. These are addressed in section 7.3 and section 7.4.

Table 7.1. Key findings from the four study components and mixed methods integration

Study component 1: Systematic review	Study component 2: Analysis of quantitative data	Study component 3: Qualitative study 1	Study component 4: Qualitative study 2	Mixed methods analytical integration
Migration: • Children of foreign-born Black mothers at a greater disadvantage vs those of native-born mothers • Having a foreign-born parent explains some of the higher adiposity observed in Black groups **Income:** • Possible protective effect of low income against adiposity in Black families • Not replicated consistently when using other measures of SEP **Parental weight status:** • Maternal weight may be important for children from Black and White groups (particularly girls) • Father's weight may be more important for South Asian (SA) groups **Additional potential associations:**	**Age and sex** Patterns of zBMI and odds of ov/ob across ethnic groups differ according to age and sex **Ethnic group differences:** <u>Reception year:</u> • Ethnic group differences similar for boys and girls • Children from SA, White other, Chinese and other ethnic groups had lower zBMI vs White British (WB) • Black African (BA) children had higher zBMI vs WB <u>Year 6:</u> • Boys from other White, Bangladeshi and BA groups had higher zBMI vs WB (+ SA and mixed groups had higher odds of ov/ob) • Girls from Black ethnic groups had higher zBMI vs WB (+Bangladeshi group had high odds of ov/ob)	**Universal themes:** • Health and happiness are intrinsically linked • Conceptualisations of physical activity drive the barriers and facilitators identified • Extreme views of obesity allowed children to distance themselves from obesity • Health as a choice and attribution of personal values on the basis of health • Parents, friends and schools as key influencers • Gendered body ideals and parental roles • Socioeconomic circumstances versus neighbourhood deprivation **Ethnic group specific themes:**	**Universal themes:** • The role of nostalgia upon notions of health • Conceptualisations of physical activity drive parent's concerns and restrictions • The struggle to achieve the 'healthy family' ideal • The overwhelming influence of modern life • Healthy lifestyles fostered in schools • Supporting parents: Family, community, government **Ethnic group specific themes:** • African life vs British life • The symbolic nature of body size • Cultural heritage narrated through food • Gender, physical activity and notions of dignity	**Universal threads:** • Autonomy and academic focus may drive increases in adiposity over the course of childhood • Gendered societal body size ideals may drive lower adiposity in girls vs boys • Perceived positive role of school not supported by quantitative findings • Strong influence of neighbourhood safety, crime, aesthetics and low access to play and leisure opportunities upon children's PAL **BAC groups (threads):** • Cultural-contextual interaction (African life vs UK life) may drive increased risk of adiposity following migration,

Study component 1: Systematic review	Study component 2: Analysis of quantitative data	Study component 3: Qualitative study 1	Study component 4: Qualitative study 2	Mixed methods analytical integration
• Low parental education protective for native-born Black children • Children's attitudes towards food and parental restrictive feeding patterns associated with obesity in Black African and Caribbean (BAC) children	**School and neighbourhood effect:** • Small effect of school and neighbourhood upon zBMI • Neighbourhood IMD consistently associated with adiposity • School IMD associated with adiposity for Y6 children only • IMD did not explain ethnic group patterns in childhood adiposity • IMD inversely associated with zBMI for reception year BA and Bangladeshi boys **Measurement of adiposity:** • Adjusting for ethnic group variation in height and fat mass changed ethnic group patterns in zBMI (Black and SA groups). • Ethnic group patterns remained largely similar when using IOTF cut-offs (except Chinese)	• Status attached to traditional food practices varied by country of origin • Differing body size ideals • The influence of religious practices upon diet and physical activity behaviours • Migration: new contexts drive behavioural change	• Transitions in culturally-linked behaviours and beliefs **Sociodemographic characteristics underlying beliefs and experiences:** • Ethnicity, faith and migration • Deprivation and socioeconomic position	particularly influential for low SEP groups **SA groups (threads):** • Cultural body size ideals; group food norms; and generational decline in traditional diet may contribute to increased odds of adiposity. Limited explanation for heterogeneity across Indian, Pakistani and Bangladeshi children's risk of adiposity • Academic prioritisation may contribute to increased odds of adiposity in older SA groups • Limited explanation for the basis of gender-based differences in weight status in SA children.

7.3 Application to existing conceptual models of childhood obesity

One of the gaps highlighted in the existing literature was the applicability of existing socioecological systems models of obesity for conceptualising the determinants of childhood obesity for those from minority ethnic groups, to determine their cross-cultural applicability (Ludwig *et al.*, 2011; Osei-Kwasi *et al.*, 2016). Below, the findings are reflected upon in light of two key models that have informed this study: a socioecological model (SEM) (Harrison *et al.*, 2011b; Sallis *et al.*, 2008), and the Community Energy Balance (CEB) model (Kumanyika *et al.*, 2012). An overview of these models is provided in Table 1.7(Chapter 1).

7.3.1 Socioecological model

In their review of the literature, Harrison *et al.* (2011b) summarised a small number of potentially important contributors to obesity development across childhood. However, the authors acknowledged the model was not exhaustive and highlighted the need to tailor broad ecological models of child adiposity to children's developmental stage and to high-risk populations. In Appendix 30, key findings from the study have been mapped onto the Six Cs SEM (Harrison *et al.*, 2011b), highlighting a number of additional 'factors' that this research has identified and adds to the existing model. A number of proximal-distal factor interactions (the so called 'meso-system' within ecological systems theory) were explicitly identified or can be hypothesised on the basis of the study's findings. Consideration has been given to such interactions in Appendix 30. However, although it is acknowledged that the potential for interactions between the contributors identified here is vast, given the focus of the current study, only interactions between ethnicity, migration/generation and other contributors have been identified. Finally, consideration of the contribution of 'time' (or the 'chronosystem') is also explored in Appendix 30, bearing in mind three key chronological structures that appeared to have the most relevance within the current study: the life-course; time following migration; and societal change over time.

The mapping of the study findings were intended to support the identification of salient issues relating to obesity risk within an ethnically diverse population such as Coventry, and to highlight the ways in which issues interact across multiple levels. This mapping can support the design of services and interventions that take into account these multiple levels of influence, and can act upon not just the individual child or family behaviours, but upon the drivers of these behaviours also. This mapping supported the identification of suggestions for intervention and service design in section 7.4.

7.3.2 Community Energy Balance Model

The CEB model proposed by Kumanyika *et al.* (2012) also has relevance in this study, given the study's aim of exploring cultural and contextual factors that influence perspectives and experiences specifically in relation to children's ethnicity. The aim of this model was to emphasise factors of particular relevance to the energy balance of *communities* (ethnically distinct and living within majority reference populations), with the aim of developing a set of intervention considerations. A number of study findings can be profiled within this framework, to guide thinking around cultural-contextual variables that influence risk of adiposity in minority ethnic groups.

7.3.2.1 Changes over time, across generations, and over the life course in society at large

Diet: Increased availability of high energy foods was thought by parents to be driven by societal changes which included progression from a local to global society and the ubiquity of technology, which resulted in a focus on the manufacturing of cheap, poor quality, energy dense convenience foods. This was supported by a change in expectations towards convenience and food ‘on demand’. Coupled with the loss of the traditional ‘family unit’, this meant that less value was placed on family mealtimes (typically associated with healthy good quality meals) in favour of convenience foods (typically viewed as unhealthy and energy dense).

Physical activity: Parents felt nostalgic for the freedom granted in their own childhoods, and felt a sense of loss of this freedom for their own children, which limited children’s ability to be physically active. Parents felt that this was a result of an increase in societal dangers (parents acknowledged that this was ‘perceived’ and driven by greater awareness of dangers through TV and the internet); and the loss of community. The progression towards globalisation put demands on family life, forcing families to work harder and longer. Coupled with the ubiquity of technology, including screens and motorized transport, this limited children’s ability to be physically active and made sedentary behaviours the default.

7.3.2.2 Intervention settings and agents

7.3.2.2.1 General population and culture in host country or area

In this instance, the UK is the background against which obesity interventions happen, a country which acknowledges the need to address childhood obesity and social inequalities in health, but is showing signs of moving away from an ‘upstream’ response towards one of individual responsibility (see Chapter 1).

7.3.2.2.2 Communities

The communities (defined here as ‘cultural and structural entities’) most apparent in the current study included universal communities: schools and neighbourhoods; and minority communities: South Asian*;* African (both African and Caribbean parents identified with this community); the church; Muslim faith (although this was rarely explicitly referred to);

and migrant status (for example, Caribbean migrants discussed shared experiences with African migrants).

7.3.2.2.3 Families

The wider family was influential for South Asian participants, who described a strong influence of elders upon body size ideals and dietary intake; and family norms reinforced over a wide family network e.g. gendered expectations and pressures upon the body size ideals of females. The wider family was less important for those from African backgrounds as a result of migration. Some participants described small family networks in the UK, but many still acknowledged the role of grandparents and 'elders' in influencing children's dietary behaviours, and reinforcing cultural food traditions (e.g. role of food in hospitality) and body size ideals.

7.3.2.2.4 People

The CEB model views ethnicity as an extra structuring force that influences the 'habitus' of individuals (the negotiation of personal agency with the social setting). Minority status is viewed as contributing to a constant pressure/disharmony in which one's own cultural views and perspectives are regularly challenged by that of the majority population. Options for the minority individual are to assimilate or reject this scenario, resulting in acculturation or marginalisation/an overemphasis on ethnic identity, respectively. The current study identified some examples of participants assimilating to the majority 'habitus', including adapting approaches to parental discipline (African participants); and attempts from females to exercise in public (South Asian participants). However, few examples of marginalisation or overemphasis of ethnic identity were identified.

7.3.2.3 Intervention targets

Potential intervention targets and strategies are identified in section 7.4, with specific reference to *child* obesity, since the CEB model does not distinguish between adult and child obesity. Of particular interest in the CEB model is the delivery of contextually and culturally appropriate advice and interventions, and the congruence of advice and interventions with cultural norms and expectations. These are considered in section 7.4 in relation to findings from two key minority ethnic groups in the current study: Black African and Caribbean and South Asian children and families.

7.3.2.4 Cultural-contextual influences

7.3.2.4.1 Historical experiences and adaptations, and type of minority status

There were two 'types' of minority status in the current study, as defined by Kumanyika *et al.* (2012): "established" migrants (generally South Asian) and "new" migrants (generally African). The CEB model proposes differential challenges in structural and sociocultural contexts based on type of minority status. In this study, for Black African and Caribbean parents, experiences of migration were particularly influential, with parents contrasting African and British life, narrating cultural heritage through food, and renegotiating traditional body size ideals. These renegotiations resulted in adaptive behaviours within the new context, generally through acculturation, although there remained a desire to retain some traditional practices (e.g. traditional meals) which sometimes lead to conflict between parents and children, and contributed to the sense of family food as 'a battle'. For South Asian families, there was also evidence of the persistence of traditional beliefs, which also contributed to health behaviours, including traditional body size ideals, group norms in relation to food practices, and gendered notions of dignity related to physical activity. These traditional viewpoints were also prone to negotiation, although this appeared to link to generational decline or 'attenuation' rather than a change in context, since many of these families are UK-born. However, in both minority status groups (new and established migrants), parents discussed low levels of support for maintaining or adapting healthy behaviours linked to their historical experiences e.g. doing female group-based physical activities.

One additional point to note is the experiences of one child who had recently moved to the UK from Iran. This child provided an account which was in opposition to the migratory experiences described by African parents. For this boy, his migration involved a move from a culture he described as *restrictive* upon health behaviours to one which he felt was *supportive* in comparison. These restrictions were driven by the political and socioeconomic climate in his country of origin. This comparison highlights the contrasting influences of historical experiences and adaptations dependent on country of origin, and a need to acknowledge these distinctions in local service design.

7.3.2.4.2 Structural influences

This study has highlighted a number of structural influences upon obesity development, which were highlighted in study component 4 (qualitative interviews with parents) within 'sociodemographic characteristics underlying beliefs and experiences'. The majority of parents in the current study, regardless of ethnicity, lived in deprived areas. Neighbourhood deprivation acted to restrict physical activity in particular, through high crime and anti-social behaviour, and low access to open green space. SEP influenced parental workloads (e.g. working long hours, shift work), transport mobility, and financial resources, generally acting to restrict physical activity and healthy eating (i.e. purchasing of cheap takeaway food). Although these experiences were not confined to the minority ethnic groups in the present study, they were clearly a feature of the lives of those from minority ethnic groups. Given knowledge about the relative disadvantage experienced by most minority ethnic groups in the UK, factors linked to SEP are likely to be more important in these groups compared to the majority population. Structural influences sometimes interacted with ethnicity or migratory status e.g. socioeconomic disadvantage (individual influence) prohibited purchasing of expensive fruit and vegetables (structural influence), restricting maintenance of traditional African diets.

Experiences of racism and discrimination are included in the CEB model as structural influences, however, experiences of racism and discrimination did not emerge from the qualitative data, and the systematic review failed to identify any influence of these factors upon child adiposity, in contrast with findings in adults (Paradies *et al.*, 2015), and from outside the UK (Priest *et al.*, 2013).

7.3.2.4.3 Sociocultural influences

'Cultural anchors' (Kumanyika *et al.*, 2012) were apparent in findings from study component four (qualitative research with parents), for example, the symbolic nature of food in hospitality and social status, and of body weight upon social status. The current study supports the idea of these cultural anchors as a result of 'deeply embedded' cultural memories of the past, such as historical experiences of food insecurity. As described in Chapter 6, these cultural anchors may drive obesity due to their persistence in modern obesogenic contexts, and these structural-sociocultural interactions may predispose ethnic minority populations toward obesity.

7.3.2.5 Summary

Reflecting on the ways in which the findings from the current mixed methods study correspond with the CEB model has supported the identification of obesity-related factors of greatest relevance to the minority ethnic groups represented in the current study and has identified considerations that can be incorporated into intervention planning. Some elements from the CEB model were not applicable to the findings in the current study – this may be the result of a lack of relevance of these issues in the Coventry population or due to methodological factors e.g. racism and discrimination did not arise as issues for parents and children in the current study, but this may be due to a reluctance to discuss the issue rather than its lack of relevance. In particular, the value of the CEB model is that it has highlighted the interactions between structural, socio-cultural and contextual elements, supporting the identification of contributors to childhood obesity at multiple levels of influence and further underlining the need for a systems approach to tackling childhood obesity in minority ethnic groups.

7.4 Implications for intervention and service design

An additional gap in the literature was the application of knowledge of local population-specific characteristics and contexts to intervention development (Brown *et al.*, 2015; Liu *et al.*, 2012; National Institute for Health and Care Excellence, 2007; 2014b), particularly interventions that acknowledge the impact of the environment, setting and context in their design. The application of existing health promotion interventions to minority ethnic groups is not well studied, with most interventions taking a general population approach. However, as outlined in the current study, there are challenges unique to specific ethnic groups which may make a generic approach less effective in minority ethnic groups. Given the presence of ethnic disparities in childhood obesity, a *tailored* approach may therefore be required to prevent an intervention-generated *widening* of these disparities (White *et al.*, 2009).

In a review on the effectiveness of culturally tailored interventions for minority ethnic groups, Liu *et al.* (2012) state that *"decisions on adaptation need to be based on a detailed understanding of the target community"* (p.149). Nastasi and Hitchcock (2016) also propose that interventions attend to culture and context in their design, through *evidence-based cultural grounding* i.e. an approach of adaptation based on formative research to systematically examine the cultural factors relevant. The authors claim that mixed methods research can provide *"the most informative, complete, balanced and useful research results"* (p.15) upon which to base this adaptation.

The formative, mixed methods research approach used within the current study provides this detailed understanding and evidence-based cultural grounding, upon which to base such adaptations.

7.4.1 Approaches to tacking ethnic inequalities in childhood obesity

7.4.1.1 Upstream, midstream, structural and environmental-level approaches

It should be acknowledged that 'upstream' approaches have the greatest potential to reduce inequalities in health (Adams *et al.*, 2016). Therefore universal approaches that utilise upstream approaches should be prioritised in tackling both ethnic and social inequalities in health. The findings from the current study support a range of upstream measures, which are detailed in Table 7.2, which was guided by the framework provided by Kumanyika *et al.* (2012) in the CEB model. Similar suggestions have been recommended elsewhere, however the current study provides evidence of parental and child support for these approaches.

Table 7.2 Suggestions for upstream, structural and environmental-level approaches based on findings from the current study

Intervention target	Example of intervention approaches or content
Built environment	• Provision of traffic-free open spaces for independent play. Improve neighbourhood safety, particularly residential streets free of traffic hazards e.g. Regularly closing streets to though-traffic. • Improve provision of neighbourhood leisure facilities; open, green spaces for play. • Address crime, cleanliness and anti-social behaviour to increase a sense of community. • Improve public transport links to key neighbourhood and city leisure facilities. • Interventions need to consider how cold, hot and wet weather and fewer day light hours contribute to seasonal variation in physical activity. Potential solutions include providing ideas for ways to be active indoors in wet weather; providing open and well-lit outdoor facilities for play in the winter months.
Physical activity resources, facilities, and opportunities	• Increasing the use and availability of school facilities outside of school hours as a safe, familiar place for child activities.
Food environment (products, distribution, advertising and promotion, and price)	• Food taxes on energy dense foods. • Provision and promotion of subsidies for fruit and vegetable purchasing for low income families i.e. Healthy Start. • Counter-marketing activities to decrease exposure of children to marketing of energy dense foods and drinks. • Linking with celebrity chefs and TV cookery shows to disseminate healthy eating messages. • Encourage food retailers to remove 'treat foods' from the till/prominent positions within the shop.
Government /Department of Health	• Continued funding for schools health promotion activities e.g. One Body One Life; develop teachers' roles as health educators via training on use of positive reinforcement, conversation-starters on health and sensitivity in their interactions with children on diet, physical activity and weight. • Parents may be receptive to reframing the role of digital devices as health enablers rather than barriers to health, through mHealth, eHealth and social marketing approaches.
Endorsement, social support, and social capital for physical activity and healthy eating	• Advocacy/voluntary or mandatory action for employers to improve work/life balance of employees.

7.4.2 Policy design

Policy design suggestions incorporate the targeting of interventions and services. The findings from the current study suggest the following may be appropriate:

- Targeting of recruitment for weight management interventions at groups with high risk of adiposity, in particular, boys and girls from Black African backgrounds, older girls from other Black ethnic backgrounds, and older boys from South Asian, White other and mixed ethnic backgrounds. This could include additional follow-up from the NCMP, or could be a consideration for school nurses or GPs when interacting with families from these groups. This could also be achieved through targeted recruitment at faith and community centres.
- For Black African and Bangladeshi children, it may be necessary to target across all socioeconomic groups rather than focusing on those from low socioeconomic groups.
- Consider the application of adjustment values (i.e. for fat mass) for BMI following data collection for the NCMP, to provide validity to the identification of ethnic group differences in child adiposity and improve local targeting of ethnic groups at high risk.

7.4.2.1 Universal versus culturally-adapted services and interventions

In reality, individual-level interventions (including family-level interventions), rather than upstream approaches, are favoured by government (Adams *et al.*, 2016). A number of suggestions are made on the basis of findings from the current study for universally-applicable interventions and services, which are detailed in Table 7.3, again guided by the framework provided by the CEB model.

Table 7.3 Universal suggestions for intervention and service design based on findings from the current study

Level of influence	Intervention target	Example of intervention approaches or content
Households and families	Food choices and feeding	• Interventions that aim to improve preparation of healthy, quick, easy and low cost home-cooked meals for the family. • Capitalise on parents' high level of motivation for increasing the frequency of family meals as a health-promoting opportunity, and frame the benefits of family mealtimes in these terms.
	Physical activity resources and opportunities	• Resource guides and assistance to help families identify convenient and affordable opportunities for physical activity: o Efforts should be made to inform parents about the need for additional physical activity beyond the school gates, and to create school-based interventions which actively involve parents. o Introduction of more family-based physical activity initiatives, making use of local parks and packaged as opportunities for family-bonding. Framing family-based physical activity as an opportunity for spending time as a family could maximise engagement (capitalising on parents' motivations). Providing opportunities for affordable family-based weekend activities that suit a range of ages, capabilities and interests. o Provide families with suggestions for ways to be physically active inside the home and information on the contribution of house-based activities to overall physical activity levels. Interventions could target parental perceptions of the home as a sedentary space alongside changes to the physical environment of the home. o Supporting parents in planning family physical activity around their time and financial constraints.
	Parenting approaches	• Increase opportunities to inform parents about their key role and provide suggestions for how to reinforce healthy behaviours via motivating statements and rule-setting. • Interventions aimed purely at improving parental health behaviours may positively impact upon children's health behaviours. • Parents could also be supported with skills for managing conflict over food in the house, particularly in relation to traditional food. • Strategies to help parents cope with the stress of day-to-day life which may result in more positive parenting behaviours related to diet and physical activity. • Encourage parents to limit children's screen time.
	Self-efficacy and Citizen advocacy	• Link to opportunities for engagement in community activities to promote healthier environments. • Interventions could operate to support parents at the individual-level to achieve the cognitive changes required to bridge the intention-behaviour gap (i.e. increase feelings of control).

Level of influence	Intervention target	Example of intervention approaches or content
Individuals (child)	Food choices and eating behaviours	• School-based programmes should provide suggestions for how children can implement simple healthy behaviours in the home to influence the rest of the family; involve children in school decisions relating to health. • Design of credible and relevant messages for motivating healthy behaviours based on the opportunity for making friends, ability to play, academic and sporting success, strength-building (for boys) and health for future success.
	Involvement in physical activity	• Package physical activity initiatives as opportunities for play. • Aim to improve children's and parents' resilience to poor weather conditions in relation to outdoor play. • Quick and easy activity ideas for the sedentary after-school period e.g. active play ideas.
	Weight control behaviours	• Incorporate peer-support elements into health promotion initiatives / in schools in general, particularly for children identified as overweight. • Interventions aimed at children alone could be influential in improving health beyond the individual child, and impact upon parents and siblings too.

The current study however argues for the adaptation of midstream and downstream interventions (i.e. at the community, family and individual level) individual-level services and interventions specific to ethnic groups, over-and-above the intervention components that have universal appeal (which are included in Table 7.3), to enhance relevance and applicability. Suggestions for culturally-adapted interventions and services are provided in Table 7.4, based on the framework provided in the CEB model.

Table 7.4 Culturally-adapted suggestions for intervention and service design based on findings from the current study

Level of intervention	Example of intervention approaches or content
Communities	• Address structural constraints to Muslim females participating in physical activity • Community-led walking or cycling clubs (particularly for South Asian women) • Community garden and school kitchen and garden programs (especially African and Caribbean families) • Intergenerational nutrition and physical activity programs • Church as a setting for family physical activity programmes • Linking with mosques and Islamic leaders to consider how children can be more physically active in the after-school period when attending mosque
Families and households	• Tailoring of nutrition advice and interventions: o Ideas for adapting traditional recipes with British ingredients (African families) o Parenting strategies to deal with intergenerational conflict over food o Healthy adaptations to traditional foods for South Asian families, without compromise to taste • Promotion of opportunities for all types of physical activity congruent with cultural norms and expectations • Improving the visibility of physically active Muslim female role models • Tailoring of advice and interventions to promote a positive body image / Health care delivery of obesity prevention: o Capitalise on shifting cultural body size preferences as a motivation to prevent excessive weight gain in new migrants from low/middle income countries (African parents) o Interventions aiming to improve awareness of the health risks of child obesity for African and South Asian communities (especially elders)

Support for the process of culturally-adapting health promotion interventions comes from Liu *et al.* (2012) who compiled a Tool Kit of

Adaptation Approaches for behaviour change interventions to improve the health of minority populations, which includes a 'Typology of Adaptation'. Below (Table 7.5), the suggestions detailed in this section are expanded upon with consideration of their applicability for Black African and Caribbean and South Asian families in Coventry. These have been matched to the Typology of Adaptation proposed, with consideration of the theoretical basis for the recommendation.

Table 7.5 Types of cultural adaptation and theoretical basis for adaptation for Black African and Caribbean and South Asian families

Suggested adaptation, intervention or intervention component	**Type of adaptation (Liu *et al.*, 2012)**	**Theoretical basis for suggestion**
Both Black African and Caribbean and South Asian families and parents		
• Engage with Islamic (Dogra & Barber, 2018) and Christian religious centres/leaders to understand the potential of faith centres in: o disseminating health messages o running campaigns e.g. 'walk to mosque' o delivering physical activity opportunities directly during services/madrassa/Bible study o providing a venue for delivering physical activity, healthy eating or weight management programmes	• Exploratory phase with community leaders • Ethnically matched high-level/respected individuals to increase salience of programme goals • Ethnically matched high-level/respected individuals and community members throughout planning, directing, reviewing and implementing stages • Utilise local/respected religious/spiritual leaders • Intervention considers issues unique to target population's context • Utilises and addresses target population's norms • Located in an ethnically appropriate/familiar location	• Community-wide delivery of messages, to contribute to new 'cultural norms' • Reaches families in the critical after school period, whilst not adding to the time 'burden' experienced by families
• Interventions should focus on increasing the amount of time spent together as a family instead of health benefits of family mealtimes and family physical activity	• Intervention content targets population's social and cultural values	• Messaging is targeted at nostalgia felt by parents, particularly for 'home' e.g. Africa and the Caribbean, and parents' desire for the 'healthy family ideal'
• Inclusion of grandparents in family weight management programmes • Engage grandparents in cook-and-taste sessions, and in developing ideas for healthy adaptations to traditional dishes	• Encourage/involve social support • Utilises resources from target population	• Addresses cultural pressures for a larger body size from elders, and provides additional support from influential grandparents in health behaviour change
• Broad community engagement efforts to improve sense of community in neighbourhoods in which Black African and Caribbean and South Asian families live • Neighbourhood 'play' assessments to consider the suitability of local areas for play in	• Addresses physical/financial (structural) barriers to participation • Addresses emotional barriers	• Addresses parental concerns about safety and a lack of community in the UK, helping to providing a wider social network in neighbourhoods

Suggested adaptation, intervention or intervention component	Type of adaptation (Liu *et al.*, 2012)	Theoretical basis for suggestion
neighbourhoods with a high density of minority ethnic groups e.g. *Is my neighbourhood suitable for children? "a checklist"* (Wheway, 2014) • Opening of schools / utilisation of schools as a venue for physical activity outside of school hours • Temporary street closures / 'play streets'		• Minimises additional financial and emotional burdens and feelings of stress by using familiar, safe, local venues
Black African and Caribbean families and parents		
• Community allotments in areas with a high proportion of African residents • Recipe ideas for adapting traditional African dishes using British ingredients • Distribution of health messages / recipe suggestions in fruit and vegetable markets	• Intervention content targets population's social and cultural values • Material/guidance based on preferences of target population • Provide ethnically appropriate food/activities/music	• Addresses difficulty in purchasing organic, affordable fruit and vegetables • Supports maintenance of traditional healthy diets in absence of traditional ingredients
• Healthy weight messages should focus on the health and social consequences of a large body size e.g. restricting children's mobility, diabetes and cardiovascular disease • Health professionals and doctors should consider this opportunity in consultations with African families and parents	• Intervention content targets population's *changing* social and cultural values • Cross-cultural training for all study personnel	• African parents in particular express changing perceptions of the desirability of a large body size, driven by health and social concerns • Health messaging should capitalise on this change, particularly following migration
• Interventions to incorporate parenting strategies for managing conflict over traditional family food practices • Interventions for African families should include components addressing changing disciplinary approaches, particularly those related to food • Health visitors and facilitators of parenting programmes should be aware of these changing disciplinary norms in relation to food, to incorporate this into the advice given to families	• Teaches appropriate communication skills • Intervention content targets population's *changing* social and cultural values	• Parents describe difficulty in adapting to cultural norms for disciplining children, and feel limited in their capacity to appropriately control children's food behaviours • Addresses potential unhealthy attitudes towards food for Black African children e.g. emotional eating, use of 'treat' foods

Suggested adaptation, intervention or intervention component	Type of adaptation (Liu *et al.*, 2012)	Theoretical basis for suggestion
South Asian families and parents		
• Group-based physical activity opportunities for South Asian Muslim mothers & girls led by ethnically-matched facilitators • Production and dissemination of images of South Asian women being physically active e.g. This Girl Can	• Ethnically-matched facilitators or peer role models • Gender considerations • Material depicts individuals from target population • Intervention content targets population's *changing* social and cultural values	• Contributes to new 'cultural' norms in line with parents' desires • Increases visibility of physically active South Asian women
• Engaging UK South Asian TV networks for delivery of health messaging e.g. cookery shows / endorsement of 'healthy South Asian recipes' by celebrity chefs • Cook-and-taste sessions with South Asian parents (and wider family) with healthy adaptation of traditional recipes, opportunities to taste, and ending with a community celebration	• Guidance/messages based on preferences of target population • Intervention content targets population's social and cultural values • Maintains cultural significance of food • Utilises and addresses target population's norms • Provide ethnically appropriate food/activities/music	• Provides credibility to adaptation of traditional recipes without compromising taste • Introduces the idea of healthy foods into hospitality/special occasions
• Messages for South Asian children and parents should frame the benefits of physical activity in relation to academic attainment, and should emphasise the need for physical activity outside of school hours	• Intervention content targets population's social and cultural values	• Reframes physical activity as supportive of academic attainment, rather than detrimental

It should be noted that one 'type' of adaptation has been modified for particular use in the current study: 'Intervention content targets population's *changing* social and cultural values'. This modification was made to highlight the dynamic nature of social and cultural values, and the interaction between culture and context, identified in the current study, and reflect the fact that separate messages may be needed based on whether an individual holds traditional cultural values, or 'renegotiated' cultural values.

Davidson *et al.* (2013) encourage the development and empirical testing of their Toolkit. The next logical step would therefore be to test these suggested cultural and contextual adaptations in the Coventry population through a small scale efficacy trial with an experimental design. This should be considered in light of the Pathway to Adaptation and RESET decision tool outlined by Liu *et al.* (2012), and through use of the 'participatory culture-specific intervention model' proposed by Nastasi & Hitchcock (2016).

7.5 Quality issues

The strengths and limitations of each study component are outlined in each individual chapter. However, there are a number of additional broad quality considerations applicable to qualitative research, and to mixed methods research, which were not fully discussed in previous chapters. These are discussed in more detail below.

7.5.1 Quality issues in qualitative research

O'Reilly and Kiyimba (2015) outline a number of guiding principles for quality in qualitative research. These have been considered in relation to the two qualitative study components conducted in the current study in Table 7.6.

Table 7.6 Strengths and limitations of the study in relation to guiding principles of quality for qualitative studies

Guiding principle	Strengths	Limitations
Transparency (issues relating to the auditability and rigour of the study and trustworthiness and credibility of findings)	• Systematic and transparent data collection, analysis (use of published protocol) and interpretations • Auditability could be considered high through use of a systematic published protocol for data analysis; documenting of the study process (through use of NVivo, analytical memos and a case-code matrix); and review meetings to discuss rationale for coding framework • Thick description of data provided in the results section and supported through use of quotes and images • Key findings and interpretations (in the discussion section) are grounded in the emerging themes and data (in the results section) and were discussed in review meetings with supervisors to maximise confirmability	• Researcher-selected quotes and images were chosen to represent the emerging themes • Use of a single coder may have limited full interrogation of the data and prohibited assessment of inter-rater reliability/ consistency of coding. However, supervisors did check the coding framework for quality assurance (WR, RJ and FB) • Did not use member-checking or participatory approaches
Reflexivity (an awareness of constructed nature of findings and impact on the researcher)	• As a White British/Irish researcher, participants may have provided richer descriptions of cultural perspectives and experiences • Use of methods that aimed to privilege children's perspectives and minimise the influence of the researcher during data collection • Focus group methods allow for the construction of shared experiences and social/cultural norms • A clear account of the research process is provided as well as consideration of how the methods influenced the inquiry	• Inception of study grounded on my assumption that differences in perspectives exist based on ethnic and social backgrounds • My position as a White British / Irish researcher may have influenced the data collection and study findings (as detailed in reflexive summaries) • My position as an adult researcher researching children's perspectives and my own ethnic and social background may have influenced the data collection and study findings • My assumptions may have impacted upon study findings
Transferability (applicability to other contexts)	• A focus on children and parents from deprived backgrounds was a specific focus of the research given gaps in the existing literature and desire to ensure local relevance (for informing local practice)	• Child sample consisted of participants from only urban, deprived and diverse areas, recruited from three schools in the north and east of the city of Coventry, therefore the findings may not be applicable to a broader population

Guiding principle	Strengths	Limitations
	• Provision of a detailed description of the study context is provided so that the audience can consider how the findings apply to their setting	• Parent sample consisted of participants from only urban, deprived and diverse areas, recruited from churches, community groups, schools and local programmes in the north and east of the city of Coventry, therefore the findings may not be applicable to a broader population • Findings based on ethnicity or faith cannot be said to be representative of all children/parents from such groupings due to low numbers and missing groups; the ways in which participants were recruited; the context in which the study was carried out (deprived areas in Coventry); and a lack of data on key elements of ethnicity such as faith and nationality (children) and degree of acculturation (children and parents)
Ethicality (issues relating to risk versus benefit; significance of contribution and worthiness of topic)	• Sought informed consent from children and built-in elements to maximise children's understanding of the research and ability to decide on their participation • Offered parent participants a focus group or interview for those uncomfortable in a group setting • The research makes a significant contribution to the literature by privileging children's views on health, diet, physical activity and weight via a child-led method; and by generating new insights from parents • The research meets identified needs to explore the roles of ethnicity and social background upon children's and parents' perspectives of a healthy diet and cultural and contextual factors in influencing children's risk of obesity	• Holding focus groups in faith venues may have inadvertently excluded those from other faiths, or those unfamiliar with the church may have felt uncomfortable about attending
Integrity (issues relating to epistemological	• The methods used were able to accomplish the study's key aims	• Sampling adequacy and sample size may have been limited in including enough participants from within ethnic groups (e.g. Pakistani; Black Caribbean children; Bangladeshi and Black

Guiding principle	Strengths	Limitations
congruence, authenticity and sampling adequacy)	• The sampling approach for the child study aimed for an ethnically diverse sample from deprived backgrounds, which was largely achieved • The sampling approach for the parent study aimed for a sample that included parents from ethnic groups at high risk for obesity, which was largely achieved • The research does not claim to represent a single true 'voice' of children or parents from deprived, urban, ethnically diverse UK populations	Caribbean parents) or from across a broad range of socioeconomic groups (i.e. living in areas of mid-low deprivation) • Within the child study, data collection methods may have been limited in their ability to meet the additional research aim of focusing on cultural and community-specific contextual factors that influence children's perspectives specifically in relation to children's ethnicity • Within the parent study, recruitment via churches, community groups, schools and local programmes will have influenced the make-up of the sample e.g. a high number of African participants of Christian faith • Within the parent study, interviews and focus groups were conducted entirely in English, which may have limited participation of those with limited English

7.5.2 Quality issues in mixed methods research

Curry and Nunez-Smith (2015) propose an additional set of standards for quality in the design and conduct of mixed method studies, informed by a number of existing frameworks from the mixed methods literature. These are tabulated below (Table 7.7) alongside a description of how this mixed methods study addressed each quality issue.

Table 7.7 Quality standards for the design and conduct of mixed methods studies

Domain of quality	**Addressed within current study**
Conceptualisation and justification of the study as mixed methods	• Both a quantitative and qualitative approach were considered necessary for answering specific research questions • Qualitative methods offered more scope for exploring the complexity of cultural and contextual influences upon health, and the multi-dimensionality of ethnicity • Mixing aimed to provide added value through 1) guiding the sampling and data collection of the qualitative methods (a 'development' rationale); and 2) providing depth and explanatory value to the quantitative findings (an 'expansion' rationale).
Design quality	• An explanatory sequential design was utilised in which the first quantitative stage informed the sampling and data collection methods of the qualitative phase.
Adherence to respective standards for qualitative and quantitative methods throughout the study	• Quality standards relevant to quantitative and qualitative study components were addressed in each chapter, and for qualitative study components, additionally addressed in **Error! Not a valid result for table.**
Adherence to standards for mixed methods data analysis • Resolution of divergent findings • Treatment of concordant findings • Rigour of data transformation	• The use of data coherence codes supported identification of divergent findings, and these were further elucidated in the discussion (Chapter 6) • The sampling of White, Black and South Asian groups was based on findings from the quantitative study components, as ethnic groups with high risk of adiposity. Although confounding was considered unlikely, potential measurement bias arising from use of BMI as a metric for determining variation adiposity across ethnic groups may have resulted in the inappropriate sampling of these groups for further investigation. This was however addressed in the analytical integration (Chapter 6) through use of 'scenarios' that accounted for potential measurement bias

Domain of quality	Addressed within current study
	• A type of 'selection bias' may exist through selection of data within the 'following a thread' method. It is possible that I preferentially sought findings that 'agreed' with one another. However, original data were comprehensively revisited and data were systematically organised in joint displays to support identification of any relevant data, either concordant or divergent • No data transformation was undertaken
Quality of analytical integration • Statement of the type of integration • Type of integration is appropriate for the particular design • Degree of yield	• Following a thread, joint display and triangulation protocol techniques were utilised for integration • Through an appraisal of the analytical integration, Chapter 6 demonstrated that these techniques were appropriate for an explanatory sequential design • As discussed in Chapter 6, the integrated results provided greater insight to the research issues than analysis of each study component alone • Findings from all study components were utilised to generate these mixed methods findings
Quality of interpretation • Interpretative transparency • Interpretative efficiency	• Use of joint display tables and logic models made clear which findings were generated from which study components • The meta-inferences were systematically synthesised from inferences within each study component

7.6 Recommendations for future research

There remain a number of gaps that the current study identified but was not able to address, which are summarised below.

The systematic review and NCMP analyses highlighted a lack of evidence investigating the role of ethnicity in relationships between potential explanatory factors at the community, cultural and country levels of influence and adiposity, and the extent to which such factors explain ethnic differences in child adiposity. Additional family and child factors, e.g. parenting strategies, child psychological variables also warrant further investigation. There is a general lack of literature exploring how factors at the country / macro-level influence obesity in the general population, as well as across ethnic groups.

Both the systematic review and NCMP analyses identified the need for future studies to include multiple metrics of SEP, also recommended by El-Sayed *et al.* (2011), when analysing relationships between ethnicity and childhood adiposity. Future quantitative studies should also make use of disaggregated ethnic groupings to understand differential relationships across heterogeneous populations, and may benefit from including measures of migration, generation, acculturation, and faith.

Due to the secondary analysis of data in the current study (NCMP analyses), use of a longitudinal design was not possible. Future quantitative research investigating ethnic disparities in child adiposity would benefit from a longitudinal design, which could include linking of reception year and year 6 child data within the NCMP, which will be possible in future years through the recent introduction of unique identifiers.

The NCMP analyses highlighted the potential role of metrics of adiposity in identifying ethnic group disparities. The use of ethnicity-based adjustments for BMI, or ethnic-group specific cut-offs for overweight and obesity requires further investigation in children, and is a priority within this field, to establish the extent to which ethnic group differences in zBMI and ov/ob are the result of measurement bias.

The qualitative research conducted within this study was not able to recruit adequate numbers of participants from some ethnic groups, so there remains a gap in understanding the cultural and contextual influences upon adiposity for these groups. These include Caribbean parents and children, Bangladeshi parents and Pakistani children. Incorporation of generation/migration status and faith into qualitative sampling frames may be valuable, in order to explore how these important factors interact with ethnicity to influence childhood adiposity.

Future qualitative studies may benefit from use of a more comparative approach e.g. comparing the views of children from deprived areas with those from non-deprived areas; incorporation of parent and child weight status categories (collected using objective measures) into the sampling frame to better understand how views differ across overweight and healthy weight groups; and purposive sampling of fathers to better understand the role of parental gender upon childhood obesity behaviours, in particular its' intersection with ethnicity. Use of ethnic group -specific focus groups with children may also help to elucidate any existing ethnic group-specific influences upon child health behaviours, which were not clearly apparent in the current study.

Finally, the current study can be considered formative, which is the first step in a phased approach to developing interventions. The findings reported, and recommendations made, should feed into the design and adaptation of culturally and contextually relevant child obesity interventions. These interventions should be piloted for efficacy in small-scale trials, and compared against generic interventions, in order to establish the potential for tailored interventions to reduce ethnic disparities in childhood obesity.

7.7 Conclusions and original contribution of the research

This study has made a number of unique contributions to the existing literature. Through a systematic review of the literature, this research is the first to compile a substantial body of literature to understand potential differential relationships between explanatory factors and childhood adiposity in particular ethnic groups. Although this task was also previously undertaken by El-Sayed *et al.* (2011), only two studies were found at the time. The current systematic review found 14 papers from seven studies that contributed to understanding the potential differential effects of migration and markers of socioeconomic position e.g. income and education (and their interactions), and the potential roles of maternal weight (for children from Black and White groups) and parental restrictive food practices (Black African and Caribbean groups) upon ethnic group differences in childhood adiposity. In particular, the review mostly served to highlight the lack of existing evidence to understand the basis of ethnic group inequalities.

This study also used multilevel modelling to understand ethnic group differences in childhood adiposity in the UK using NCMP data. Although other studies have used multilevel modelling techniques to analyse NCMP data (Pallan *et al.*, 2014; Townsend *et al.*, 2012; Williams *et al.*, 2015), this is the first to stratify by disaggregated ethnic groupings and explore interactions between ethnicity and deprivation. Through multilevel modelling, the analysis was able to better account for ecological effects of school and neighbourhood upon child adiposity. Through use of disaggregated ethnic groupings and stratification by age and sex, the study has also elucidated further on heterogeneous patterns in child adiposity within South Asian and Black groups in particular.

The use of a child-centred qualitative methodology supported the privileging of children's perspectives, identifying some new insights regarding both universal and ethnic group specific influences upon child obesity. Universal influences included the central role of happiness in children's conceptualisations of health, the presence of negative value judgements as a result of the ways in which children moralised health; a distancing of childhood obesity from children's own lives; and children's rationalisation of healthy choices over habitual ones. Ethnic group specific factors included mental well-being and academic achievement as particular motivators for keeping healthy in South Asian and Black African groups; the valuing of homemade food for Black African children; and potential differential body size ideals for South Asian and Black African children. However, as a whole, children showed low identification with ethnic group specific beliefs and practices in the current study, in relation to health and childhood obesity. This qualitative study is particularly valuable in *giving attention* to the influence of children's ethnicity and socioeconomic status upon childhood obesity beliefs and behaviours, filling a gap in the literature (Rees *et al.*, 2011; Thomas *et al.*, 2003).

Qualitative research with parents generated several new insights. These included universal findings, such as the links between the mythical 'healthy family ideal' and parents' nostalgia for the past, which drove parental conceptualisations of health and underscored many of the barriers that parents identified to keeping healthy. Ethnic group specific insights included: 1) elucidation on the challenges that African migrant parents face in adapting to 'life in the UK', which impact upon diet and physical activity; 2) the ways in which changes in parental disciplinary approaches and 'life in the UK' interact to contribute to the loss of healthy traditional food practices for African migrant families; and 3) the renegotiation of embedded cultural beliefs around body size ideals (African and South Asian groups) and participation of females in physical activity (South Asian), following migration and generational shifts, provide behaviour change opportunities.

A further contribution arises from the use of a mixed methods design. An explanatory sequential design allowed for integration at the sampling, data collection, analysis, and interpretation stages. In particular, mixed methods analytical integration was lacking within the field of childhood obesity, and its use in this study allowed for new insights to be generated. This allowed for the construction of logic models that supported understanding of the pathways leading to ethnic disparities in childhood adiposity, with the qualitative data providing depth that was not achievable from quantitative analysis alone. This study also contributes to the literature by designing and appraising an analytical method, utilising following a thread, joint display and a triangulation protocol, for the systematic integration of mixed methods data in an explanatory sequential design.

The research contributes to the theoretical basis for ethnic group disparities in health by considering the cross-cultural applicability of existing ecological systems theory models (the socioecological model and Community Energy Balance model), a gap highlighted by Ludwig *et al.* (2011) and Osei-Kwasi *et al.* (2016).

A final contribution comes from the production of a detailed, evidence-based cultural grounding of the Coventry population upon which to understand the cultural and contextual basis for ethnic group disparities in childhood obesity, and the development of a series of suggestions for policy, service and intervention design.

Appendices

Appendix 1 An overview of terms used relating to ethnicity

Adapted from (Bhopal, 2014)

Term	Usual meanings within health research	Relationships to race/ethnicity	Use within this research	Problems/issues
Ethnic minority group/minority ethnic group/Black and minority ethnic groups (BAME/BME)	Usually refers to 'non-White' populations, and sometimes includes those from other identifiable groups e.g. Roma, Irish	Varied	• 'Minority ethnic group' is used by the current researcher to incorporate all those of non-'White British' ethnicity	• Groups together very heterogeneous populations, but can be useful for referring to inequality and discrimination
General population	Usually refers to predominantly White population, but in epidemiological terms refers to everyone in the population being studied	Varied but typically refers to those from 'White' ethnic background	• This term is sometimes used by other researchers (e.g. in articles included in the systematic review) as the reference group with which to make ethnic group comparisons • Not used by the researcher in the current study	• Inaccurately used if it excludes those from minority ethnic populations
Aggregate groupings				
Black/Black African and Caribbean/Black British	A person with African ancestral origins, identified (or self-identifying) as Black, African or Afro-Caribbean, typically whose origins lie in sub-Saharan Africa	Related more directly to the construct of 'race' than ethnicity	• This term is often used by other researchers (e.g. in articles included in the systematic review) to aggregate those from African and Caribbean backgrounds • Occasionally used as an aggregate grouping in the current study to combine African and Caribbean groups	• The cultural, social and genetic diversity captured by the term is vast • 'Black' sometimes used by other researchers to refer to all non-White populations
Asian	Anyone originating from the Asian sub-continent	Does not relate specifically to a 'race'	• This term is often used by other researchers (e.g. in articles included in the systematic review) to aggregate those from South Asian backgrounds (UK) or with Far Eastern origins (US) • Used by the NCMP data to refer to South Asian ethnic groups and other Asian groups not	• The cultural, social and genetic diversity captured by the term is vast

Term	Usual meanings within health research	Relationships to race/ethnicity	Use within this research	Problems/issues
			represented by the Chinese ethnic group	
South Asian/British South Asian	A person whose ancestry lies in countries in the Indian subcontinent, including Indian, Pakistan, Bangladesh and Sri-Lanka	Does not relate specifically to a 'race'	• Sometimes used in the current research to aggregate those from Indian, Pakistani, Bangladeshi and other South Asian census groups, or who had described themselves as originating from countries in the Indian sub-continent	• Individuals rarely self-identify with this aggregate grouping
White/White British/White Other	Typically applied to those of White, European ancestry (or British in this case)	Characterised by light complexion, Caucasian is used synonymously with this term	• White British and White Other are used as separate terms in the current research to distinguish those with migratory histories beyond Britain	• Use of the term 'White' describes heterogeneous populations
Caucasian	Typically synonymous with the term 'White'	Relates to race rather than ethnicity, defined by those of Indo European geographical origin (the 'Caucasus')	• This term is often used by other researchers (e.g. in articles included in the systematic review) to described those with White European ancestry • Not used by the researcher in the current study	• Is widely misapplied and is decreasingly used
Mixed ethnicity	The offspring of a couple from different ethnic groups	Varied	• Used in NCMP analyses to group all those from any mixed ethnic backgrounds • Used in the qualitative research to group those self-describing their ethnicity as mixed	• An increasingly important category, and sometimes provides an opportunity to self-define ethnicity • Extremely heterogeneous so statistical analysis with this category is largely meaningless
Other ethnicity	Usually used to aggregate smaller ethnic groups not included within the categories specified	Varied	• Used in NCMP analyses to group all those from any groups not categorised as a major ethnic group, or those choosing to self-define their ethnicity • Includes varied ethnic groups, but largely those defining their	• Usually provides an opportunity to self-define ethnicity • Extremely heterogeneous so statistical analysis with this category is largely meaningless

Term	Usual meanings within health research	Relationships to race/ethnicity	Use within this research	Problems/issues
			ethnicity as Arabic (a specific category in the NCMP data set)	
Disaggregated groupings				
African-Caribbean/Afro-Caribbean/Caribbean	Typically refers to a person of African origin ancestral origins whose family settled in the Caribbean before emigrating	See African	• Was a category of the NCMP data set • Was included as a categorical option for data collection in the qualitative research • Some parents used this term to self-define their ethnicity • Some parents described their country of origin and this was used by the researcher to aggregate those with origins in an island of the Caribbean	• Lacks detail regarding island of origin and migration history
African/Black African	A person with African ancestral origins, but excluding those of other ancestry e.g. Eurpoean	Approximates to the racial group usual referred to as 'Black'	• Was a category of the NCMP data set • Was included as a categorical option for data collection in the qualitative research • Some parents used this term to self-define their ethnicity • Some parents described their country of origin and this was used by the researcher to aggregate those with origins in a country on the African continent	• Lacks detail regarding country of origin and migration history • Excludes those from north African countries in some research
Indian/British Indian	Belonging or relating to India/native to India	Does not relate specifically to a 'race'	• Was a category of the NCMP data set • Was included as a categorical option for data collection in the qualitative research • Some parents used this term to self-define their ethnicity	• Consists of heterogeneous populations, and further qualification is useful e.g. Indian Gujarati

Term	Usual meanings within health research	Relationships to race/ethnicity	Use within this research	Problems/issues
Pakistani/British Pakistani	A person whose ancestry lies in the Indian subcontinent, originating from the territory now known as Pakistan	Does not relate specifically to a 'race'	• Was a category of the NCMP data set • Was included as a categorical option for data collection in the qualitative research • Some parents used this term to self-dedefine their ethnicity	• Some Pakistanis may have ancestral roots in lands now classified as Indian but identify as Pakistani
Bangladeshi	A person whose ancestry lies in the Indian subcontinent, with originating from the territory known as Bangladeshi (previously East Pakistan)	Does not relate specifically to a 'race'	• Was a category of the NCMP data set • Was included as a categorical option for data collection in the qualitative research	• Changes in politics and geography mean that identify with this country may be ill-defined
Chinese	A person with ancestral origins in China	Does not relate specifically to a 'race', rarely analysed in racial terms	• Was a category of the NCMP data set	• Consists of heterogeneous populations
Additional terms used in the current research				
British Muslim/Muslim	Not typically used in health research as it describes a religion rather than an ethnicity	Does not relate specifically to a 'race'	• Some parents used this term to self-define their ethnicity	• Allowed participants to self-define the element of their ethnicity most relevant to them • Offers little indication of country of origin

Appendix 2 Systematic review findings by ethnic group at biological level

Factor	Study	Overall findings	Sub-group findings			
			White / White British	Black	Asian	Other
Biological						
Birthweight	Brophy, 2009 (IOTF cut-offs)	>3.5kg at birth = ↑ odds obesity at age 5 (OR 1.47 (95%CI:1.27-1.7) in unadjusted model)	**White European**: No interaction	**African:** No interaction	**Asian:** No interaction	n/a
	Rona, 1987 (weight-for-height)		**Caucasian:** significant association with weight-for-height (p<0.001) and triceps SFT (p<0.001)	**Afro-Caribbean:** significant association with weight-for-height (p<0.05) but not triceps SFT	**Gujarati:** significant association with weight-for-height (p<0.001) **Punjabi:** significantly associated with weight-for-height (& explained a small amount of the variation) in both adjusted models (p<0.001) and with triceps SFT (p<0.001) **Urdu:** No association **Other Asian:** No association	**Other:** No association
Parental height						
Mother's height	Rona, 1987 (weight-for-height)		**Caucasian:** Significant association with weight-for-height (p<0.001) and triceps SFT (p<0.001)	**Afro-Caribbean:** Significant association with weight-for-height (p<0.001) but not triceps SFT	**Gujarati:** No association **Punjabi:** Significant association with weight-for-height (Model 1: p<0.05; Model 2: p<0.01)) but not triceps SFT **Urdu:** No association **Other Asian:** No association	**Other:** No association
Father's height	Rona, 1987 (weight-for-height)		**Caucasian:** Significant association with weight-for-height (p<0.001) but not triceps SFT	**Afro-Caribbean:** No association	**Gujarati:** significant association with weight-for-height (p<0.001) and triceps SFT (p<0.01)	**Other:** No association

Factor	Study	Overall findings	Sub-group findings			
			White / White British	Black	Asian	Other
					Punjabi: significant association with weight-for-height ($p<0.001$) **Urdu:** No association **Other Asian:** significant association with weight-for-height (Model 1: $p<0.05$; Model 2: $p<0.01$)	

Appendix 3 Systematic review findings by ethnic group at child level

Factor	Study	Overall findings	Sub-group findings			
			White / White British	Black	Asian	Other
Health behaviours						
Fruit consumption	Zilanawala, 2015 (IOTF)	No association	**White:** Reference group	**Black African:** continued to have a significantly ↑ BMI after adjusting for portions of fruit/day **Black Caribbean:** continued to have a significantly ↑ BMI after adjusting for portions of fruit/day	**Indian:** continued to have a significantly ↓ BMI after adjusting for portions of fruit/day **Pakistani:** continued to have a significantly ↓ BMI after adjusting for portions of fruit/day **Bangladeshi:** remained similar to reference group	**Other**: continued to have a significantly ↓ BMI after adjusting for portions of fruit/day
	Brophy, 2009 (IOTF cut-offs)	↓ intake of fruit = ↑ odds for obesity in crude models (OR for ≤1 portions/day = 1.2 (95%CI: 1.01-1.4)) but NS after adjusting for income	**White/European:** No interaction	**African:** No interaction	**Asian:** No interaction	n/a
Regular mealtimes	Brophy, 2009 (IOTF cut-offs)	Irregular mealtimes = ↑ odds for obesity in crude models (OR = 1.3 (95%CI: 1.02-1.7)) but NS after adjusting for income	**White/European:** No interaction	**African:** No interaction	**Asian:** No interaction	n/a
Breakfast skipping	Brophy, 2009 (IOTF cut-offs)	Irregular breakfast = ↑ odds for obesity in crude models (OR = 1.3 (95%CI: 1.02-1.7)) (OR = 1.6 (95%CI: 1.3-2.0)), with the exception of those with no qualifications. NS after adjusting for income.	**White/European:** No interaction	**African:** No interaction	**Asian:** No interaction	n/a

Factor	Study	Overall findings	Sub-group findings			
			White / White British	Black	Asian	Other
Physical activity	Brophy, 2009 (IOTF cut-offs)	Exercising <1 day/week = ↑ odds for obesity in crude models (OR = 1.25 (95%CI: 1.08-1.45). NS after adjusting for income.	**White/European:** No interaction	**African:** No interaction	**Asian:** No interaction	n/a
	Owen, 2010 (multiple measures)	Strong -ve graded associations between activity counts and adiposity markers (particularly sum of SFT) in adjusted multilevel models	**White European:** Similar across all groups	**African Caribbean:** Similar across all groups	**South Asian:** Similar across all groups	**Other:** Similar across all groups
Sedentary behaviour	Brophy, 2009 (IOTF cut-offs)	≥3 hours TV/day = ↑ odds of obesity (OR 1.47 95%CI: 1.2-1.8) in crude models (significant after adjustment)	**White European:** No interaction	**African Caribbean:** No interaction	**Asian:** No interaction	**Other:** No interaction
	Brophy, 2009 (IOTF cut-offs)	≥3 hours computer/day = ↑ odds of obesity (OR= 1.42 (95%CI: 1.0-2.07) in crude models	**White European:** No interaction	**African Caribbean:** No interaction	**Asian:** No interaction	**Other:** No interaction
Sleep	Zilanawala, 2015 (IOTF)	No association	**White:** Reference group	**Black African:** continued to have a significantly ↑ BMI after adjusting for sleep **Black Caribbean:** continued to have a significantly ↑ BMI after adjusting for sleep	**Indian:** continued to have a significantly ↓ BMI after adjusting for sleep **Pakistani:** ↓ BMI became significant after adjusting for sleep (OR 0.71 (95%CI: 0.53–0.96) $p<0.05$)) **Bangladeshi:** remained similar to reference group	**Other:** continued to have a significantly ↓ BMI after adjusting for sleep
Psychological factors						
Child food approach	Blissett, 2013 (BMI SDS)		**White British:** No association	**African Caribbean:** significant +ve	n/a	n/a

Factor	Study	Overall findings	Sub-group findings			
			White / White British	Black	Asian	Other
				correlation with BMI SDS (0.42; $p<0.05$)		
Child food avoidance	Blissett, 2013 (BMI SDS)		**White British:** No association	**African Caribbean:** No association	n/a	n/a
Enjoyment of physical activity	Brophy, 2009 (IOTF cut-offs)		**White European:** ↑ enjoyment of PA = ↓ odds of obesity (OR = 0.7; 95%CI: 0.5-0.96) in crude model. NS after adjustment for income and education.	**African Caribbean:** Too few numbers to estimate	**Asian:** No association	**Other:** No association
Migration factors						
Foreign-born parent	Martinson, 2012 (CDC)		**White:** No difference between foreign-born and native-born White; no significant interactions.	**Black:** Native-born mother = ↑ odds of overweight vs native-born White after adjusting for education (Model 6 Coeff = 0.82 ($p<0.05$)), but not income (Model 5 Coeff = 0.71). Foreign-born mother = ↑ odds of overweight vs native-born White after adjusting for income (Model 5 Coeff = 1.47 ($p<0.01$)) and education (Model 6 Coeff = 1.18 ($p<0.01$)). Significant -ve interaction for native-born X low education (Model 6 Coeff = -1.02 ($p<0.01$)).	**Asian:** Native-born mother = ↑ odds of overweight vs native-born White after adjusting for income (Model 5 Coeff = 0.56 ($p<0.1$) but not mother's education (Model 6 = 0.41). NS differences between foreign-born Asian mothers and native-born White. Significant -ve interaction native-born X low income (Model 5 Coeff = -0.87 ($p<0.05$))	n/a
	Martinson, 2015 (BMI)		**White:** No difference in growth trajectories between foreign-born and native-born White.	**Black:** Growth trajectories from 3 - 7 years significantly steeper for children of	**Asian:** Growth trajectories from 3 - 7 years significantly steeper for children of	n/a

Factor	Study	Overall findings	Sub-group findings			
			White / White British	Black	Asian	Other
				Black mothers vs native-born White, especially for children of foreign-born Black mothers (slope coefficients for Native-Born Black = 0.15 (SD=0.04) p<0.01 and for Foreign-Born Black = 0.29 (SD=0.04) p<0.01). Girls gain at a faster rate than boys for children of foreign-born Black mothers (figures not presented).	Asian mothers vs native-born White (slope coefficients for Native-Born Asian =0.10 (SD=0.03) p<0.01 and for Foreign-Born Asian = 0.06 (SD=0.03) p<0.05)	
	Smith, 2010	No significant difference in children with 2nd vs 1st generation mother after controlling for socioeconomic and behavioural factors	**White British:** No significant difference in children with 2nd vs 1st generation mother **White Other:** No significant difference in children with 2nd vs 1st generation mother	**Black African:** No significant difference in children with 2nd vs 1st generation mother. In models comparing to White reference group, 2nd generation mothers = ↑ odds of excess weight 2.01 (1.30-3.09) **Black Caribbean:** 2nd generation = ↓ odds of excess weight vs 1st generation mother (0.23 (95%CI: 0.07-0.74) p<0.05) in fully adjusted models. In models comparing to White reference group, 1st generation mother = ↑ odds of excess weight 2.69 (95%CI: 1.29-5.64)	**Indian:** No significant difference in children with 2nd vs 1st generation mother **Pakistani:** No significant difference in children with 2nd vs 1st generation mother **Bangladeshi:** No significant difference in children with 2nd vs 1st generation mothers	n/a

Factor	Study	Overall findings	Sub-group findings			
			White / White British	Black	Asian	Other
	Henderson, 2010 (multiple)		n/a	n/a	**British Pakistani:** no significant differences in adiposity 2nd vs 3rd generation children. 2nd generation boys = ↑% overweight vs 3rd generation using IOTF cut-offs for BMI (chi-squared: p=0.011) and UK90 cut-offs for subscapular SFT (p=0.045) but not UK90 cut-offs for BMI, WC or triceps SFT. No significant difference in overweight or overfat for girls for these categories.	n/a
Mother's age at arrival	Martinson, 2012 (CDC)		**White:** no association	**Black:** no association	**Asian:** no association	n/a
Composite measure of migration	Zilanawala, 2015 (IOTF)		**White:** Reference group	**Black African:** continued to have a significantly ↑ BMI after adjusting for language and generation **Black Caribbean:** continued to have a significantly ↑ BMI after adjusting for language and generation	**Indian:** continued to have a significantly ↓ BMI after adjusting for language and generation **Pakistani:** continued to have a significantly ↓ BMI after adjusting for language and generation **Bangladeshi:** remained similar to reference group	**Other:** continued to have a significantly ↓ BMI after adjusting for language and generation

Appendix 4 Systematic review findings by ethnic group at family level

Factor	Study	Overall findings	Sub-group findings			
			White / White British	Black	Asian	Other
Parental health behaviours						
Pre-pregnancy weight	Brophy, 2009 (IOTF cut-offs)	Pre-pregnancy weight >60kg = ↑ odds of obesity (OR 1.9; 95%CI: 1.6-2.3 in adjusted models)	**White European:** No interaction	**African:** No interaction	**Asian:** No interaction	n/a
Mother's weight status	Rona, 1987 (weight-for-height)		**Caucasian:** Significantly associated with weight-for-height (p<0.001) and triceps SFT (p<0.001)	**Afro-Caribbean:** Significantly associated with weight-for-height (p<0.05) but not triceps SFT	**Gujarati:** No association **Punjabi:** significantly associated with weight-for-height (p<0.001) but not triceps SFT **Urdu:** No association **Other Asian:** significantly associated with weight-for-height in Model 1 only (p<0.05). Not associated with triceps SFT	**Other:** No association
	Zilanawala, 2015 (IOTF)		**White:** Reference group	**Black African:** continued to have a significantly ↑ odds of excess weight after adjusting for maternal BMI weight status (OR 1.49 (95%CI: 1.13–1.98) p<0.01 for overweight; 1.72 (95%CI: 1.12–2.64) p<0.05 for obese). Maternal BMI explained the ↑ BMI in this group (no longer significant) **Black Caribbean:** continued to have a significantly ↑ BMI and odds of after adjusting for	**Indian:** continued to have a significantly ↓ BMI and NS difference in odds of excess weight **Pakistani:** continued to have a significantly ↓ BMI and NS difference in odds of excess weight **Bangladeshi:** ↑ odds of obesity significant after introducing maternal BMI (OR = 1.70, 95%CIs: 1.04–2.78, p<0.05)	**Other:** continued to show NS difference in odds of excess weight. Maternal BMI explained the ↓ BMI observed (no longer significant)

Factor	Study	Overall findings	Sub-group findings			
			White / White British	**Black**	**Asian**	**Other**
				maternal BMI weight status (OR=2.00 95%CIs: 1.38-2.91, p<0.001)		
	Martinson, 2012 (CDC 85th percentile)	Maternal obesity = ↑ odds of overweight (coefficient=0.85, p<0.01)	**White:** Mother's obesity does not change relationship	**Black:** Mother's obesity does not fully mediate relationships	**Asian:** Mother's obesity does not change relationship	n/a
	Higgins, 2012 (IOTF cut-offs)		**White:** Maternal obesity = ↑ odds of excess weight in girls and boys **Irish:** Girls: Maternal obesity = ↑ odds of excess weight. Boys: No association (figures not provided).	**Black African:** Maternal obesity = ↑ odds of excess weight in girls and boys **Black Caribbean:** Maternal obesity = ↑ odds of excess weight in girls and boys	**Indian:** Maternal obesity = ↑ odds of excess weight in girls and boys **Pakistani:** Maternal obesity = ↑ odds of excess weight in girls and boys **Bangladeshi:** Girls: Maternal obesity = ↑ odds of excess weight. Boys: No association (figures not provided).	**Chinese:** Maternal obesity = ↑ odds of excess weight in girls and boys
Father's weight status	Higgins, 2012 (IOTF cut-offs)		**White**: Girls: Father's obesity = no association. Boys: Father's excess weight = ↑ odds of excess weight. **Irish:** Paternal obesity = ↑ odds of excess weight in girls and boys	**Black African:** Paternal obesity = ↑ odds of excess weight in girls and boys **Black Caribbean:** Paternal obesity = ↑ odds of excess weight in girls and boys	**Indian:** Paternal obesity = ↑ odds of excess weight in girls and boys **Pakistani:** Paternal obesity = ↑ odds of excess weight in girls and boys **Bangladeshi:** Girls: Father's obesity = no association. Boys: Father's excess weight = ↑ odds of excess weight.	**Chinese:** Paternal obesity = ↑ odds of excess weight in girls and boys
	Rona, 1987 (weight-for-height)		**Caucasian:** Significantly associated with weight-for-height (p<0.001) and triceps SFT (p<0.001)	**African-Caribbean:** No association	**Gujarati:** Significantly associated with weight-for-height (p<0.001) and triceps SFT (p<0.001) **Punjabi:** Significantly associated with weight-for-height (p<0.001) and triceps SFT (p<0.001)	**Other:** Significantly associated with weight-for-height in Model 2 only (p<0.05) but not triceps SFT

Factor	Study	Overall findings	Sub-group findings			
			White / White British	Black	Asian	Other
					Urdu: No association **Other Asian:** Significantly associated with weight-for-height (p<0.05) but not tricep SFT	
Parental smoking	Brophy, 2009 (IOTF cut-offs)	Smoking near child = ↑ odds of obesity (OR 1.3, 95% CI: 1.02-1.6 in adjusted models)	**White European:** No interaction	**African:** No interaction	**Asian:** No interaction	n/a
Socioeconomic characteristics						
Parental education	Brophy, 2009 (IOTF cut-offs)	Parental age of leaving school >18 (vs <16) = ↓ odds for obesity (OR=0.55, CIs: 0.4-0.77) after adjustment for income and education	**White European:** No interaction	**African:** No interaction	**Asian:** No interaction	n/a
	Martinson, 2012 (IOTF cut-offs)	Parental low education levels (O'levels or below vs A'levels or above) = ↑ odds of overweight (coefficient = 0.18, p<0.05 in model adjusted for maternal obesity).	**Native born White:** Reference group **Foreign-born White:** No association	**Native-born Black:** parental low education = ↓ odds for overweight (beta coefficient = -1.02; p<0.01 - model adjusted for maternal BMI) **Foreign-born Black:** No association	**Native-born Asian:** No association **Foreign-born Asian:** No association	n/a
	Higgins, 2012 (IOTF cut-offs)		**Irish:** Boys: No association. Girls: inconsistent across subgroups, figures not presented	**Black African:** Boys: No association. Girls: inconsistent across subgroups, figures not presented **Black Caribbean:** Boys: No association. Girls: inconsistent across subgroups, figures not presented	**Indian:** Boys: No association. Girls: not stated **Pakistani:** Boys: No association. Girls: inconsistent across subgroups, figures not presented **Bangladeshi:** Boys: No association. Girls: inconsistent across	**Chinese:** Boys: No association. Girls: inconsistent across subgroups, figures not presented

Factor	Study	Overall findings	Sub-group findings			
			White / White British	Black	Asian	Other
					subgroups, figures not presented	
Employment						
Mother	Rona, 1987		**Caucasian**: no association	**African-Caribbean:** No association	**Gujarati:** No association **Punjabi:** No association **Urdu:** No association **Other Asian:** No association	**Other:** No association
Father	Rona, 1987		**Caucasian:** Father's employment status significantly associated with triceps SFT	**African-Caribbean:** No association	**Gujarati:** No association **Punjabi:** No association **Urdu:** No association **Other Asian:** No association	**Other:** No association
Hours working	Rona, 1987		**Caucasian:** associated with weight-for-height but not triceps SFT	**African-Caribbean:** No association	**Gujarati:** No association **Punjabi:** No association **Urdu:** No association Other Asian: No association	**Other:** No association
Income	Brophy, 2009 (IOTF cut-offs)	↓ income = ↑ odds of obesity (OR = 0.77 (95%CI: 0.7-0.85)	**White European:** inverse relationship	**African:** NS trend ↑ income = ↑ prevalence of obesity (vs middle and low income)	**Asian:** inverse relationship	n/a
	Martinson, 2012 (CDC 85th percentile)	No association	**White:** no interaction	**Black:** Significant interaction income X foreign-born mother (beta coefficent = -1.13; p<0.1)	**Asian:** Significant interaction income X native-born (beta coefficent = -0.87; p<0.05).	n/a
	Karlsen, 2013 (IOTF)		**White English:** no difference vs other groups (except Black African and Black Caribbean), no change when adjusted for income.	**Black African:** ↑ probability of overweight vs other groups, ↑ probability of obesity versus White English and Chinese, not explained by	**Indian:** no difference vs other groups, no change when adjusted for income. **Pakistani:** no difference vs other groups, no	**Chinese:** no difference vs other groups, no change when adjusted for income. **Other:** no difference vs other groups, no change

Factor	Study	Overall findings	Sub-group findings			
			White / White British	Black	Asian	Other
			White Irish: no difference vs other groups, no change when adjusted for income. **White Other:** no difference vs other groups, no change when adjusted for income.	income. In sex-stratified models, ↑ probability of obesity in boys and ↑ probability of overweight in girls vs White English was explained by income. **Black Caribbean:** ↑ probability of obesity versus White English and Chinese, not explained by income.	change when adjusted for income. **Bangladeshi:** no difference vs other groups, no change when adjusted for income. **Other South Asian:** ↓ probability of overweight vs White English and Black African, not explained by household income	when adjusted for income.
Class / status	Higgins, 2012 (IOTF cut-offs)	Overall inverse relationship between social class and overweight and obesity for boys only	**Irish:** Boys: no relationship with weight status. Girls: inconsistent - results not presented	**Black African:** Boys: no relationship with weight status. Girls: inconsistent - results not presented **Black Caribbean:** Boys: no relationship with weight status. Girls: inconsistent - results not presented	**Indian:** Boys: no relationship with weight status. Girls: inconsistent - results not presented **Pakistani:** Boys: no relationship with weight status. Girls: inconsistent - results not presented **Bangladeshi:** Boys: no relationship with weight status. Girls: inconsistent - results not presented	**Chinese:** Boys: no relationship with weight status. Girls: inconsistent - results not presented
	Thomas, 2012		**White European:** ↓ NS-SEC = ↑ adiposity across all measures (e.g. Ponderal index: % difference per NS-SEC from high to low = 1.71 (0.75, 2.68) p<0.001).	**Black African-Caribbean:** ↓ NS-SEC = ↓ adiposity using Ponderal index only (SFT, WC & % FM = NS) (Ponderal index: % difference per NS-SEC from high to low = -1.12 (-2.01, -0.21) p<0.01).	**South Asian:** no association	n/a
	Rona, 1987		**Caucasian:** no association	**Afro-Caribbean:** no association with weight-for-height; but associated with triceps SFT (p<0.05).	**Gujarati:** No association **Punjabi:** No association **Urdu:** No association	**Other:** No association

Factor	Study	Overall findings	Sub-group findings			
			White / White British	Black	Asian	Other
					Other Asian: No association	
Deprivation / poverty	Townsend, 2009 (UK90, cut-offs unclear)	IMD = +ve association with odds of obesity (1.01 (1.01,1.01) p<0.01). IMD explained an additional 0.4% of variation between groups (R^2 = 0.04) vs model with ethnicity and urban environment alone (R^2=0.37)	**White British & Irish:** reference group	**Black African:** ↑ odds of obesity (1.55 (1.50,1.60); IMD accounted for some of increased odds but not fully attenuated (unadjusted: 1.76 (1.70,1.82)) **Black Caribbean:** ↑ odds of obesity (1.46 (1.39,1.53)); IMD accounted for some of increased odds but not fully attenuated (unadjusted: 1.63 (1.56,1.07))	**Indian:** IMD accounted for ↑ odds of obesity (unadjusted: 1.07 (1.02,1.12); adjusted: 1.03 (0.98,1.07)). **Pakistani:** ↑ odds of obesity (1.16 (1.12,1.21)); IMD accounted for some of increased odds but not fully attenuated (unadjusted: 1.35 (1.30,1.39) **Bangladeshi:** ↑ odds of obesity (1.20 (1.15,1.26)); IMD accounted for some of increased odds but not fully attenuated (unadjusted: 1.44 (1.37,1.51))	**Chinese:** ↓ odds of obesity; not explained by IMD
	Rona, 1987		**Caucasian:** No association between FSM and weight-for-height; association with triceps SFT (p<0.05).	**Afro-Caribbean:** No association	**Gujarati:** No association **Punjabi:** No association **Urdu:** No association **Other Asian:** associated with weight-for-height and triceps SFT (p<0.05).	**Other:** No association
Family size	Rona, 1987		**Caucasian:** significant association with weight-for-height triceps SFT (p<0.001).	**Afro-Caribbean:** No association	**Gujarati:** No association **Punjabi:** associated with weight-for-height (p<0.001) and triceps SFT (Model A: p<0.001; Model B: p<0.01). **Urdu:** No association with weight-for-height;	**Other:** No association

Factor	Study	Overall findings	Sub-group findings			
			White / White British	Black	Asian	Other
					significant association with triceps SFT (p<0.05). **Other Asian:** No association	
Overcrowding	Rona, 1987		**Caucasian:** no association with weight-for-height; association with triceps SFT (p<0.05)	**Afro-Caribbean:** No association	**Gujarati:** No association **Punjabi:** No association **Urdu:** No association **Other Asian:** No association with weight-for-height; association with triceps SFT (p<0.05)	**Other:** No association with weight-for-height; association with triceps SFT (p<0.05)
Composite measure	Zilanawala, 2015 (IOTF)		**White:** Reference group	**Black African**: ↑ BMI, not explained by composite measure (0.43 (0.15) p<0.01). ↑ odds of overweight and obesity, not explained by composite measure (1.69 (1.27–2.26) p<0.001 for overweight; 2.10 (1.36–3.24) p<0.001 for obesity) **Black Caribbean:** ↑ BMI, not explained by composite measure (0.48 (0.17) p<0.01). ↑ odds of obesity, not explained by composite measure (2.07 (1.43–2.99) p<0.001)	**Indian:** ↓ BMI (– 0.70 (0.12) p<0.001) and ↓ odds of overweight (0.71 (0.52–0.96) p<0.05), not explained by composite measure **Pakistani:** ↓ BMI (–0.45 (SD=0.10) p<0.001), weight status not significantly different, not explained by composite measure **Bangladeshi:** no significant difference in BMI; ↑ odds of obesity, explained by composite measure	**Other:** ↓ BMI (–0.25 (SD=0.11) p<0.05), not explained by composite measure
Parenting strategies						
Early introduction of solid food	Brophy, 2009 (IOTF cut-offs)	Solid food at <3 months = ↑ odds of obesity (OR = 1.2, 95%CI: 1.02-1.5 in adjusted model).	**White/European:** Solid food at <3 months = ↑ odds of obesity in crude model (OR = 1.5; 95%CI: 1.3-1.8) but not after	**African:** No association	**Asian:** No association	n/a

Factor	Study	Overall findings	Sub-group findings			
			White / White British	**Black**	**Asian**	**Other**
			adjustment for income and education			
Playing with child outdoors	Brophy, 2009 (IOTF cut-offs)	Games outside with child everyday = no association with odds of obesity	**White European:** No interaction	**African:** No association	**Asian:** No interaction	n/a
Playing with child indoors	Brophy, 2009 (IOTF cut-offs)	Playing indoors with child everyday = ↑ odds of obesity (OR 1.06, 95% CI: 1.03-1.08 in adjusted model)	**White European:** No interaction	**African:** No association	**Asian:** No interaction	n/a
Restrictive food practices	Blissett, 2013 (BMI)		**White British:** Parental restrictive food practices = no association with BMI SDS (0.13; p>0.05 for WB).	**Black African-Caribbean:** Parental restrictive food practices = +ve correlation with BMI SDS (correlation = 0.52; p<0.05)	n/a	n/a
Parental food monitoring	Blissett, 2013 (BMI)		**White British:** No association	**Black African-Caribbean:** No association	n/a	n/a
Parental pressure to eat	Blissett, 2013 (BMI)		**White British:** No association	**Black African-Caribbean:** No association	n/a	n/a

Appendix 5 Systematic review findings by ethnic group at community level

Factor	Study	Overall findings	Sub-group findings			
			White / White British	Black	Asian	Other
Experiences of racism	Kelly, 2012	Trend towards +ve relationship with odds of obesity but NS	No subgroup analysis	No subgroup analysis	No subgroup analysis	No subgroup analysis

Appendix 6 Aggregated ethnicity codes used in NCMP analyses

Aggregated ethnic code	**Sub-group code**
White British	White - British
White other	White - Irish, White - Any other White background
Mixed	Mixed White and Asian; Mixed White and Black Caribbean; Mixed White and Black African; , Mixed - Any other mixed background
Indian	Asian and Asian British - Indian
Pakistani	Asian and Asian British - Pakistani
Bangladeshi	Asian and Asian British - Bangladeshi
Any other Asian background	Asian and Asian British - Any other Asian background
Black Caribbean	Black or Black British - Caribbean
Black African	Black or Black British – African
Any other Black background	Black or Black British - Any other Black background
Chinese	Chinese
Other	Any other ethnic group

Appendix 7 Missing school level data

Year	**Number on roll**	**BME**	**ESL**	**KS2**
2007/8	Missing: carried back from 2008/9	Missing: carried back from 2008/9	Missing: carried back from 2008/9	Jan-08
2008/9	Jan-09	Jan-09	Jan-09	2009
2009/10	Jan-10	Jan-10	Jan-10	2010
2010/11	Jan-10	Jan-10	Jan-10	2011 (10 Schools with missing data due to KS2 tests boycott – observations carried forward from 2009/10)
2011/12	Jan-12	Jan-12	Jan-12	2012
2012/13	Jan-13	Jan-13	Jan-13	2013
2013/14	Missing: carried forward 2012/13	Missing: carried forward 2012/13	Missing: carried forward 2012/13	2014
2014/15	Jan-15	Jan-15	Jan-15	2015

Appendix 8 Ofsted re-categorisation

Final code	Current grading	Pre 2003 grading
Good or above	Grade 1 Outstanding; Grade 2 Good	Excellent (grade 1); very good (2); good (3)
Satisfactory or below	Grade 3 Satisfactory Grade 4 Inadequate	Satisfactory (4); unsatisfactory (5); poor (6); very poor (7)

Appendix 9 Cleaning and preparation of data

Data validation checks performed by data providers following cleaning by HSCIC (Health and Social Care Information Centre, 2015a)	
Data are checked if the following issues arise: • Where the proportion of children in each category of male or female and reception year or year 6 is not roughly 50% • Where school and child postcode are identical, as this may be a mistake • Where more than 10% of the records contain whole numbers for anthropometric measurements, as this may reflect a low level of accuracy in measurement recording • Where the date of measurement is a weekend, or in August, as this is likely to be a mistake • Where proportions for each weight status and ethnic group are very different to what would be expected • Where the zBMI for an observation is lower than -3 or higher than 4	
Cleaning and preparation for current analysis	
Issue	**Change made**
Separate access files for each year of measurement	All years combined into one database
Missing LSOA allocation for some schools between 2007/8 – 2011/12	School LSOA assigned to observations based on school name
Missing MSOA allocation for some child home postcodes between 2007/8 – 2011/12	Child MSOA was assigned to observations based on child LSOA
Missing BMI z-score for 2011/12	BMI z-score was assigned to observations based on BMI percentile
Missing height and weight percentiles for 2013/14 – 2014/15	Height and weight percentiles were assigned to observations based on height and weight z-scores
Child IMD decile for 2013/14 – 2014/15 was allocated in reverse order e.g. 1 as most deprived, 10 as least deprived	Child IMD decile recoded for 2013/14 – 2014/15
School urban-rural classification used additional categories in 2013/14-2014/15	School urban-rural classification was re-assigned for 2013/14-2014/15 to match pre-2013 categories
Some schools changed name or became Academies so two different unique reference numbers have been assigned across datasets	Schools with two URNs were matched and reassigned a single URN
One school moved location in 2013/14	Pre-2013 LSOA was assigned to observations for 2013/14 onwards for this school to match
Data set included data from independent or special schools	Records from independent or special schools were excluded to be consistent with NCMP data analysis procedures
Some observations had missing data	Observations with missing values (for BMI, age, sex, ethnicity, deprivation, school and neighbourhood) were removed
Data set included observations for participants residing outside of Coventry boundaries	Records with home addresses outside of Coventry boundaries were excluded
Age in months provided to one decimal point	Age in months was rounded
School data from additional (non-NCMP) sources e.g. DfE School Census data, Ofsted ratings and school denomination existed as separate data sets	Data from additional data sets was allocated by code to the existing NCMP data in Stata v14
Binary outcome required for logistic regression	Created binary variable for ov/ob versus not ov/ob based on categories designated from population cut-offs
A large number of ethnic group categories	Generated a new variable with fewer ethnic group categories

Appendix 10 Description of multilevel modelling technique

A simple single-level fixed effect regression model can be presented as follows:

(1)

$$y_i = \beta_0 + e_i$$

where y_i is the value of y for the i^{th} individual, β is the mean of y in the population, and e_i is the individual residual for the i^{th} individual.

Single levels models were explored separately for reception year and year 6.

The simple multilevel model allows for group differences in the mean of y by generating a two-level structure with individuals (level 1) within groups (level 2). The residual is therefore split into two components as follows:

(2)

$$y_{ij} = \beta_0 + u_j + e_{ij}$$

where y_{ij} is the value of y for the i^{th} individual in group j, β remains the overall mean of y in the population, u_j is the group-level residuals for the j^{th} group, and e_{ij} is the individual residual for the i^{th} individual in group j.

Residuals are assumed to follow normal distributions. Based on the residuals, the variance is partitioned into two components: between-group variance σ_u^2 and within-group variance σ_e^2.

The cross-classified model with no explanatory variables may be expressed as:

(3)

$$y_{i(j1,j2)} = \beta_0 + u_{j1} + u_{j2} + e_{i(j1,j2)}$$

Where $j1$ refers to schools and $j2$ refers to neighbourhoods. Additional variance parameters are created: σ^2_{u1j1} and σ^2_{u1j2} (or alternatively $\sigma^2_{u(1)}$ and $\sigma^2_{u(2)}$) which are the variances of the coefficient for school and neighbourhood separately, and σ_{u01j1} and σ_{u01j2} which are the covariances between the constant and coefficient for school and neighbourhood separately. The two variances are adjusted for one another.

The null was created first to examine the effect of school on zBMI, with school and/or neighbourhood fitted as level 2 random effects alongside the fixed effect component. Ethnic group was added to the model (model 1) to explore variation in zBMI across ethnic groups whilst allowing the value of β_0 to vary randomly across schools (to account for the school or neighbourhood effect), represented as follows for the simple model:

(4)

$$y_{ij} = \beta_0 + \beta_1 x_{1j} + u_j + e_{ij}$$

where β_0 is the intercept (or constant) and β_1 is the slope (or coefficient) for explanatory variable x for the i^{th} individual in group j.

The equivalent cross-classified model can be described by the following notation:

(5)

$$y_{i(j1,j2)} = X_{i(j1,j2)}\beta + u_{j1} + u_{j2} + e_{i(j1,j2)}$$

Pupil, school and neighbourhood covariates and pupil-level interaction terms were added to the model as fixed effects (as in the single-level model) to establish the adjusted estimates for zBMI across ethnic group, and establish any school or neighbourhood effects upon the adjustment (models 2 - 5). Covariate selection was based on improvement in the Bayesian Deviance Information Criterion.

The variance partition coefficient (VPC) was calculated to establish the proportion of total variance that is attributable to level two clustering as follows for the simple two-level model:

(6)

$$VPC_u = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_e^2}$$

And as follows for the cross-classified model (in this example, the equation indicates the school VPC):

(7)

$$VPC_{u(1)} = \frac{\sigma_u^2}{\sigma_{u(1)}^2 + \sigma_{u(2)}^2 + \sigma_e^2}$$

Appendix 11 Sample characteristics by ethnic group, reception year

Reception		White British	Other White	Indian	Pakistani	Bangladeshi	Other Asian Backgrounds	Black - Caribbean	Black - African	Other Black Backgrounds	Chinese	Other	Total
Sex		%	%	%	%	%	%	%	%	%	%	%	%
F		48.5	47.2	50.2	47.6	49.6	49.2	47.5	49.1	49.7	53.1	49.5	48.7
M		51.5	52.8	49.8	52.4	50.4	50.8	52.5	50.9	50.3	46.9	50.5	51.3
Year of measurement		%	%	%	%	%	%	%	%	%	%	%	%
2007/08		11.1	5.1	11	11.1	11.5	9	10.9	6.6	6.7	8.5	6.4	9.8
2008/09		11.8	6.2	12.5	11.8	12.6	9.3	10	8.6	7.1	3.1	10	10.9
2009/10		12.3	8.5	11.3	12.2	14.3	9.3	13.6	12.3	9.3	5.4	13.5	11.9
2010/11		12.6	8.6	12.2	11.9	12.4	11.8	10.8	13.5	8	9.2	15	12.4
2011/12		12.4	12.4	12.7	12.3	12.6	14.4	14.6	14.5	9	13.1	18	13.2
2012/13		13.2	17.1	14.5	14.7	12	17.3	13.3	15.3	7.7	15.4	12.9	13.9
2013/14		12.8	19.9	13.5	13.6	11.1	13.5	13.1	12.2	33	21.5	15.2	13.7
2014/15		13.9	22.2	12.2	12.5	13.5	15.5	13.7	17	19.2	23.8	8.9	14.2
Height z-score	Mean	0.02	0.22	0.24	0.36	0.12	0.01	0.47	0.70	0.63	-0.05	0.17	0.15
	SD	1.06	1.10	1.12	1.09	1.07	1.08	1.09	1.14	1.14	1.12	1.11	1.10
Age (months)	Mean	59.8	59.6	60.0	59.8	59.8	59.9	59.5	59.3	60.0	60.0	59.5	59.7
	SD	4.12	4.15	4.04	4.17	4.03	4.20	4.21	4.18	4.02	4.15	4.24	4.14
School IMD Quintile		%	%	%	%	%	%	%	%	%	%	%	%
1		8.3	5.7	16.8	4.5	5	6.6	4.5	1.8	3.8	23.8	3.4	7.5
2		20.6	5.8	8.5	5.1	6.1	9.8	10.2	3.2	2.9	16.9	8.5	14.3
3		30.7	19.2	23.7	9.4	4.6	21.4	28.9	15.9	17.3	16.2	22.2	25.3
4		18.3	25.4	23.1	16.1	11.1	21.4	22.6	22.6	22.4	13.1	21.9	19.8
5		22.1	43.9	27.9	64.9	73.3	40.7	33.8	56.4	53.5	30	44	33.1
Ofsted grading		%	%	%	%	%	%	%	%	%	%	%	%
Good or above		58.9	59.5	62.4	61.2	57.2	56.8	57.1	51.4	63.8	79.2	50.2	58
Satisfactory or below		41.1	40.5	37.6	38.8	42.8	43.2	42.9	48.6	36.2	20.8	49.8	42
School roll (no.)	Median	387	398	457	457	572	409	394	344	376	380.5	385	396
	Lower IQR	249	253	324	345	360	278	243	232	252	237	244	256
	Upper IQR	473	474	534	539.5	673	517	493	439	475	485	491	482
BME (%)	Median	29.7	50.9	45.5	79.3	81.9	48.4	42.4	53.3	52.2	45.5	43.6	38.1
	Lower IQR	19.4	33.2	33.1	49.1	55.2	33.0	26.8	36.9	33.5	27.7	30.8	23.9
	Upper IQR	43.1	64.5	57.9	92.9	92.1	71.8	53.9	71.3	65.6	59.4	61.7	54.8
ESL (%)	Median	15.8	34.4	27.4	69.6	70.2	30.4	23.5	37.3	33.2	26.9	27.6	22.5

Reception		White British	Other White	Indian	Pakistani	Bangladeshi	Other Asian Backgrounds	Black - Caribbean	Black - African	Other Black Backgrounds	Chinese	Other	Total
	Lower IQR	8.9	19.0	16.5	29.7	39.8	18.1	12.7	21.4	19.9	13.5	15.8	11.7
	Upper IQR	27.2	48.0	43.3	83.6	81.1	57.8	38.8	52.4	51.4	44.1	46.9	39.5
KS2 Level 4+ (%)	Median	76.5	73.3	76.7	70.6	70.8	72.4	73.3	71.4	73.3	78.6	70.8	75.0
	Lower IQR	66.7	64.0	64.5	60.3	59.9	61.1	63.6	61.0	67.2	70.8	61.2	64.5
	Upper IQR	84.4	82.9	84.4	78.8	80.4	80.8	82.9	81.0	82.8	85.1	80.0	83.3
FastFood (no.)	Median	2	2	2	3	3	2	2	2	2	1	2	2
	Lower IQR	0	1	1	1	2	1	0	1	1	0	1	1
	Upper IQR	3	5	5	6	8	5	4	6	5	5	5	5
Home IMD Quintile		%	%	%	%	%	%	%	%	%	%	%	%
1		4.8	1.9	10.1	1.9	3.5	2.2	1.9	0.4	0	6.9	1.7	4
2		17.1	7.1	10.5	4.1	3	9.5	5.7	2.4	1.9	18.5	5.8	12.1
3		22.8	13.7	20.1	10.5	4.1	17.5	16.9	7.8	8	28.5	14.5	18.6
4		25.2	25.7	30.7	15.3	15.9	26.2	28.7	19.7	21.2	20	24.1	24.5
5		30.1	51.6	28.5	68.2	73.5	44.7	46.7	69.8	68.9	26.2	54	40.7
Total		**16055**	**1655**	**2335**	**1540**	**460**	**1564**	**826**	**2629**	**312**	**130**	**2221**	**29727**

Appendix 12 Sample characteristics by ethnic group, year 6

Year 6		White British	Other White	Indian	Pakistani	Bangladeshi	Other Asian Backgrounds	Black - Caribbean	Black - African	Other Black Backgrounds	Chinese	Other	Total
Sex		%	%	%	%	%	%	%	%	%	%	%	%
F		49.6	49.2	48.2	47.4	49.8	46.1	46.5	51.0	51.9	52.1	52.0	49.3
M		50.4	50.8	51.8	52.6	50.2	53.9	53.5	49.0	48.1	47.9	48.0	50.7
Year of measurement		%	%	%	%	%	%	%	%	%	%	%	%
2007/08		13.2	7.6	11.6	10.6	9.4	8.5	14.2	9.7	10.0	14.1	8.6	11.9
2008/09		12.2	9.7	11.7	10.8	12.3	8.7	12.0	10.6	8.1	14.1	9.5	11.5
2009/10		13.0	9.9	12.7	11.6	12.6	11.7	12.2	12.4	11.9	8.5	9.5	12.4
2010/11		12.8	12.4	13.6	12.7	11.3	12.2	12.5	10.8	11.3	9.9	8.6	12.4
2011/12		12.4	13.8	12.3	13.5	13.8	12.6	12.2	13.1	9.4	11.3	9.8	12.4
2012/13		11.9	15.9	12.4	13.7	13.8	15.4	12.2	15.4	11.9	15.5	6.9	12.4
2013/14		11.9	14.5	11.6	13.3	13.2	15.4	12.4	12.3	17.5	12.7	26.4	13.2
2014/15		12.5	16.2	14.1	13.9	13.6	15.3	12.2	15.7	20.0	14.1	20.7	13.8
Height z-score	Mean	0.17	0.32	0.39	0.3	0.11	0.17	0.48	0.69	0.76	-0.08	0.34	0.25
	SD	1.06	1.06	1.09	1.11	1.08	1.08	1.09	1.16	1.09	1.04	1.12	1.09
Age (months)	Mean	132.11	132	132.16	131.7	131.87	132.15	132.25	131.65	132.2	132.3	132.24	132.07
	SD	4.29	4.13	4.24	4.23	4.28	4.15	4.33	4.11	4.31	4.25	4.24	4.26
School IMD Quintile		%	%	%	%	%	%	%	%	%	%	%	%
1		8.8	6.8	17.4	4.2	6.2	8.2	3.7	1.5	3.8	21.1	4.2	8.3
2		19.9	5.7	8.9	5.4	5.5	8.0	9.7	2.0	3.1	25.4	7.8	14.6
3		31.1	20.3	23.4	7.3	4.5	21.9	30.0	14.9	26.9	25.4	21.4	26.3
4		18.8	22.4	21.1	13.6	8.3	22.2	22.9	23.6	23.1	16.9	24.0	19.6
5		21.4	44.8	29.2	69.4	75.5	39.6	33.8	58.1	43.1	11.3	42.6	31.2
Ofsted grading		%	%	%	%	%	%	%	%	%	%	%	%

Year 6		White British	Other White	Indian	Pakistani	Bangladeshi	Other Asian Backgrounds	Black - Caribbean	Black - African	Other Black Backgrounds	Chinese	Other	Total
Good or above		58.4	57.5	58.7	64.8	63.6	55.5	50.4	50.4	56.3	74.6	62.8	58.2
Satisfactory or below		41.6	42.5	41.3	35.2	36.4	44.5	49.6	49.6	43.8	25.4	37.2	41.8
School roll (no.)	Median	385	396	462	457	582	408	397	338	356	407	408	400
	Lower IQR	245	247	323	325	420	261	251	234	227	228	287	249
	Upper IQR	472	472	572	568	691	506	474	446	465.5	493	502	489
BME (%)	Median	29.7	50.4	46	85.1	85.15	48.4	41.3	54.4	42.95	33	47.2	36.9
	Lower IQR	19.4	31.8	33.5	52.4	58.1	33	27.4	40.6	32.65	19	31.3	23.6
	Upper IQR	43.1	65.2	58.7	93	95.3	69.7	54.5	72	61.95	45.5	64	53.9
ESL (%)	Median	15.7	33.9	28.2	73.4	77.2	32.6	25.2	38.8	26.95	15	31.1	21.4
	Lower IQR	8.9	18	17.7	36.8	42.4	17.9	13.9	23.4	16.4	8.5	16.7	11.2
	Upper IQR	26.9	48.9	43.3	83.9	84.1	51.4	39.2	57.8	43.1	26.9	49.2	38.7
KS2 Level 4+ (%)	Median	76.7	74.1	75	71.4	69.95	73.3	73.3	70.8	71.75	80	74.2	75
	Lower IQR	66.7	63.9	63.3	62.1	59.7	62.9	62.1	60.3	62.5	74.2	65	64.7
	Upper IQR	84.7	83.3	83.3	78.7	77.8	82.6	81.8	80.5	80	86.4	82.4	83.3
FastFood (no.)	Median	2	2	2	3	2	2	2	2	2	1	2	2
	Lower IQR	0	1	1	1	2	1	1	1	1	0	1	1
	Upper IQR	4	5	5	6	8	5	5	6	5	3	6	5
Home IMD Quintile		%	%	%	%	%	%	%	%	%	%	%	%
1		5.7	2.4	11.5	2.3	5.5	5.8	2.2	1	0.6	9.9	2.3	5.3
2		18.3	8.5	12.1	4.7	4.3	8.6	7.8	1.8	5	25.4	6.5	13.9
3		24.2	15.8	18.4	9.6	3.4	17.6	17	7.9	13.1	19.7	16.5	20.2
4		24.9	22.5	29.6	12.7	10.2	26.5	28.5	20.2	28.1	28.2	25.5	24.3
5		26.9	50.8	28.4	70.6	76.6	41.5	44.4	69	53.1	16.9	49.1	36.3
Total		**15992**	**1190**	**2283**	**1381**	**470**	**1193**	**817**	**1582**	**160**	**71**	**1543**	**26682**

Appendix 13 Refining the model: Comparing data structures

	Bayesian DIC	
	Reception	**Year 6**
Single level model	89453	87219
School multilevel model	89097	87050
Neighbourhood multilevel model	89224	87098
Cross classified model	89060	87028

Appendix 14 Comparing model fit with introduction of variables (linear models)

	Reception			Year 6		
Covariate	**Whole sample (n = 27803)**	**Girls (n = 13524)**	**Boys (n = 14279)**	**Whole sample (n = 25763)**	**Girls (n = 12667)**	**Boys (n = 13096)**
Null model	83440	39594	43842	84035	41352	42615.41
Ethnicity	82878	39337	43528	83955	41272	42591.18
Sex	83439	n/a	n/a	83961	n/a	n/a
Year	83417	39587	43828	84037	41354	42616.84
Age	83435	39592	43841	84034	41354	42612.3
School IMD	83438	39589	43842	84027	41342	42611.81
Ofsted	83441	39595	43844	84037	41353	42616.95
Roll	83426	39589	43832	84036	41351	42616.48
BME	83437	39594	43837	84036	41353	42615.94
ESL	83439	39594	43839	84035	41352	42616.04
KS2	83441	39595	43843	84035	41349	42617.89
Fastfood	83441	39592	43843	84036	41352	42616.96
IMD	83432	39583	43837	84018	41337	42603.93
	n = 28407	n = 13828	n = 14579	n = 25763	n = 12667	n = 13096
Final model	84535	40161	44357	83865	41254	42585
Final model without ethnicity	85105	n/a	n/a	83944	n/a	n/a
Year interaction	84557	40172	44369	n/a	n/a	n/a
School IMD interaction	n/a	n/a	n/a	n/a	41267	42588
Neighbourhood IMD interaction	84554	40164	44351	83875	41264	42582

Appendix 15 Comparing model fit with introduction of variables (binary models)

	Reception			Year 6		
Covariate	**Whole sample (n = 27,803)**	**Girls (n = 13,524)**	**Boys (n = 14,279)**	**Whole sample (n = 25,763)**	**Girls (n = 12,667)**	**Boys (n = 13,096)**
Null model	30101	14312	15723	33202	16034	17154
Ethnicity	29956	14251		33150	15994	17108
Sex	30088		15806	33175		
Year	30101	14313	15807	33204	16035	17157
Age	30102	14311	15800	33204	16034	17154
School IMD	30094	14305	15809	33187	16021	17145
Ofsted	30104	14313	15803	33205	16037	17158
Roll	30097	14311	15805	33205	16034	17155
BME	30100	14312	15804	33202	16032	17147
ESL	30100	14310	15809	33202	16034	17149
KS2	30103	14313	15805	33203	16033	17158
Fastfood	30100	14310	15794	33205	16033	17152
IMD	30076	14288	15807	33187	16021	17145
	n = 28,407	n = 13,828	n = 14,579	n = 25,763	n = 12,667	n = 13,096
Final model	30585	14577	16033	33109	15979	17103
Sex interaction	30591	n/a	n/a	33076	n/a	n/a
Neighbourhood IMD interaction	30575	14586	16013	n/a	15992	17103
School IMD interaction	n/a	n/a	n/a	33119	15992	17098

Appendix 16 Study component three: participant information sheet for children

Family Health in Coventry

We would like to ask you to take part in a research study.

Before you decide if you would like to join in, you should know what the study is about. Talk to your parents before you decide. Your opinion is important.

You may have some questions. If so, you can ask your parents to call or email us. We can talk it through with you and your parents.

What is research?

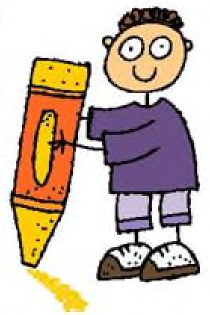
Research is the way we find answers to questions. In this study, we are trying to find out what children think about health.

Child PIS part 2 v1 260116

THE UNIVERSITY OF WARWICK
WARWICK MEDICAL SCHOOL

Why have I been asked to take part?

We would like to talk to children your age in Coventry. Your classmates have also been asked if they want to take part.



Do I have to take part?

No. The choice is up to you and your parents. If you change your mind, that is okay too. You can stop the research at any time. Just let your parents or the researcher know.

What will happen if I take part?

A researcher from the University will visit your school. She will speak to you on your own, away from the class. She will ask you to draw some pictures. You will also be asked some questions. If you are happy to do so, this will be recorded on a voice recorder. She will also make a copy of your drawings.

When the study is over, we will combine all the children's data. We will write a report on what we have found.

Will my personal information be kept private?

We will keep information about you very safe and private. Your name will not be used in the report. Your classmates may know that you have taken part. However, they won't know what you have said.

To contact us, you should call or email Marie Murphy at the University of Warwick: ✉ Marie.murphy@warwick.ac.uk ☎ 07725745411

Appendix 17 Study component three: parent information sheet

Parent PIS part 2 v2 10/03/16

Study of Family Health in Coventry

THE UNIVERSITY OF WARWICK
WARWICK MEDICAL SCHOOL

We would like to invite your child to take part in a research study at school.

Before you decide if you are happy for your child to take part, it is important to know why the research is being done and what it would involve.

Please take time to read this information sheet. Talk to others about the study if you wish. If you have any questions, you can call or email the researcher. Contact details are given at the end of this sheet.

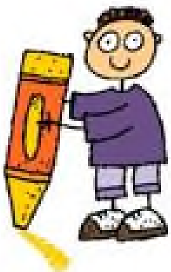
Important things that you should know

What is the study about? We would like to know what children in Coventry think about health, and in particular health behaviours. This includes topics such as diet, physical activity and body size.

Why has my child been asked to take part? We are interested in the views of children in year 4 or 5 of primary school in Coventry. We have asked your child's classmates if they would like to take part too.

What will my child have to do? A researcher from the University will visit your child's school. She will speak to your child on their own, away from the class.

1. The researcher will explain the research to your child and ask if they are happy to take part.
2. They will be asked to draw some pictures and to answer some questions to find out their views on health.
3. Your child will also be asked some questions about their family and home, such as what languages they speak at home. This is to make sure a good range of children's views are heard.
4. If your child agrees, the meeting will be recorded on an audio recorder and a copy of the drawings will be made.



The meeting will last up to 30 mins. Your child can keep their drawings to take home.

What will I have to do? If you are happy for your child to take part, please fill-in and return the form enclosed. We have included a stamped addressed envelope that you can use.

Does my child have to take part? No. The choice to take part is entirely up to you and your child. If you or your child change your mind, you can stop the research at any time before or during the study.

You can also ask to withdraw your child up to 3 months after taking part in the study. In this case, we will do our best to remove your child's quotes or drawings from any written reports.

What are the possible disadvantages of taking part?

Your child will need to take time out of their school day. We will ask your child's teacher to choose a good time during the lesson or break time for the interview. We want to make sure this doesn't disturb their curriculum learning.

Some of the topics that come up in discussion may be personally sensitive to your child. The researcher will stop the interview if your child becomes upset. If needed, school pastoral support will also be available.

What are the possible benefits of taking part?

Your child may enjoy the drawing activity and the chance to give their views about health.

At the end of the research, we hope to use the findings to support other children in Coventry to be healthy. By taking part in the research, your child's input will help other children in the future.

Will my child be safe? The interview will be carried out in the school in an open but quiet area. The researcher has an up-to-date enhanced Disclosure and Barring Service check and has had experience in working with children. If a safety concern arises, the school's safeguarding procedures will be followed.

Will my child's information be kept private? We will keep information about your child very safe and private. Your child's personal information will be kept in a password-protected electronic folder and physical copies in a locked filing cabinet. It will be kept for 5 years and then will be safely disposed of.

Reports of the research will be written. These will include quotes and drawings from your child and other children. Your child's name or name of their school will not be used in any reports. The research may also be presented in teaching or training materials.

Who has reviewed the study? The study has been approved by the Biomedical and Scientific Research Ethics Committee (BSREC) at the University of Warwick.

Thank you for taking the time to read this information. For more information about the study, please contact:

Marie Murphy
(PhD Researcher)
University of Warwick
Marie.murphy@warwick.ac.uk
07725745411

What if I have a problem?

Any complaint about the way you or your child have been dealt with during the study or any possible harm your child might have suffered will be addressed seriously. Please address your complaint to the person below, who is a senior University of Warwick official entirely independent of this study:

Director of Delivery Assurance
Registrar's Office
University House
University of Warwick
Coventry
CV4 8UW
Complaints@Warwick.ac.uk
024 7657 4774

Who is funding the research? The research is funded through the National Institute of Health Research (NIHR). You can find out more about the research at: http://www2.warwick.ac.uk/fac/med/about/centres/clahrc/

NHS
National Institute for Health Research

Appendix 18 Study component three: screening questionnaire

Parent Questionnaire part 2 v1 26/01/16

ID	

Parent Questionnaire

In this survey, you will be asked for basic background information about your child. This will help us to ensure a good range of children's views are heard.

Your name	
Child's name	
Child's usual address	
Postcode	

Please tick the option that best describes your child's ethnicity:

White- British	☐	Asian- Indian	☐
White- Irish	☐	Asian- Pakistani	☐
White- Gypsy or Traveller	☐	Asian- Bangladeshi	☐
White- European	☐	Asian- Chinese	☐
Mixed- White and Black Caribbean	☐	Black- African	☐
Mixed- White and Black African	☐	Black- Caribbean	☐
Mixed- White and Asian	☐	Arab	☐
Prefer not to say	☐	Other (please specify): ____________	

Appendix 19 Study component three: parental consent form

Parent consent form part 2 v2 10/03/16

ID	

Study of Family Health in Coventry

THE UNIVERSITY OF WARWICK
WARWICK MEDICAL SCHOOL

Parent consent form

Please tick

1. I confirm that I have read and understand the information sheet (dated 10/03/16) for this study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my child's participation is voluntary and that he/she is free to withdraw at any time without giving any reason, with no negative consequences. I understand that my child may decline even if I have given consent ☐
3. I understand that the information my child and I give will remain confidential and anonymous. ☐
4. I understand that my child's interview will be audio recorded. ☐
5. I agree for my child to take part in the above study. ☐

Child's name	
Child's class	

Appendix 20 Study component three: child questionnaire

ID		Sex	
Class		Ethnic group	
School			

Child questionnaire (Interview administered)

These questions are about you and family. Please can you tell me…

1. How old are you?		
2. Does your family own a car, van or truck?	No	☐ [0]
	Yes, one	☐ [1]
	Yes, two or more	☐ [2]
3. Do you have your own bedroom for yourself?	No	☐ [0]
	Yes	☐ [1]
4. During the past 12 months, how many times did you travel away on holiday with your family?	Not at all	☐ [0]
	Once	☐ [1]
	Twice	☐ [2]
	More than twice	☐ [3]
5. How many computers does your family own?	None	☐ [0]
	One	☐ [1]
	Two	☐ [2]
	More than two	☐ [3]
6. Where you born in the UK?	Yes	☐ [1]
	No	☐ [2]
7. If not the UK, how many years have you lived here?		
8. Was your father born in the UK?	Yes	☐ [1]
	No	☐ [2]
9. Was you mother born in the UK?	Yes	☐ [1]
	No	☐ [2]
10. Which language do you usually speak at home?	English	☐ [1]
	Another language	☐ [2]

Appendix 21 Study component three: semi-structured topic guide

Interviews with children

Informed consent

- Introduction – use the participant information sheet to explain the research.
- Ask child to report back:
  - *"what will I be talking to you about today?"*
  - *"what should you do if you don't want to talk to me anymore?"*
- Show the child the digital recorder and allow them to press buttons.
- Obtain verbal consent and begin the recording
- Interview-administered questionnaire

Beliefs and experiences

Activity
Draw, write and tell activity: Draw a picture of a 'healthy' child and the kinds of things you think helps him or her to keep healthy. Next, draw an 'unhealthy' child and the kinds of things you think cause him or her to be unhealthy. Ask: *can you tell me about your picture please?*
Key questions
– [If have drawn picture of 'illness'] Can you now draw a child with a 'healthy habits' and 'unhealthy habits'? How is this different to your first pictures? – What kind of things does he/she like to eat and drink? – What kind of things does he/she like to do at school and at home? – What size is this child compared to other children? – What kind of personality do you think he/she has? – What do you think his/her family is like? – What do you think his/her school and neighbourhood is like? – What kinds of feelings and emotions does this child have? – What do other children think of this child? – Is there anything you would like to add or change about the picture?
Prompts: Personal experiences
Let's imagine that there is a scale – at one end is this healthy child, and at the other is this unhealthy child. – Where do you think you are on this scale? Who are you most similar to? – What makes you say that? – Would you like to be like this child? Why? – What would you have to do to be more like this child? – How similar is this child to your classmates?

Finish

Ask if the child is happy for you to take a scan of their picture. Give the child the option to keep their picture if they would like to.

Thank the child for taking part and tell them who they can talk to if they would like support.

Appendix 22 Study component four: screening questionnaire

Screening questionnaire Part 1 v2 081216

Study of Family Health in Coventry

Name:	
Address:	
Phone number:	
When is the best time to call you?	
Email address:	

Would you prefer me to contact by phone or email? Phone ☐ Email ☐

Do you have any children (or grandchildren) under the age of 18? Yes ☐ No ☐

If needed, we have access to interpreters who can translate our discussion in your chosen language. If you do decide to participate, would you like to use an interpreter?

Yes ☐ Please specify: ____________ No ☐

Do you have any access and/or communication requirements that we need to be aware of? (If yes, please describe)

Please tick the option that best describes your ethnicity:

A) White:
- ☐ English/Welsh/Scottish/Northern Irish/British
- ☐ Irish
- ☐ Gypsy or Traveller
- ☐ Any Other White Background, write here: ____________

B) Mixed / multiple ethnic groups
- ☐ Mixed White and Black Caribbean
- ☐ Mixed White and Black African
- ☐ Mixed White and Asian
- ☐ Any other mixed / multiple ethnic background, write here: ____________

C) Asian / Asian British:
- ☐ Indian
- ☐ Pakistani
- ☐ Bangladeshi
- ☐ Chinese
- ☐ Any other Asian background, write here: ____________

D) Black / African / Caribbean / Black British:
- ☐ African
- ☐ Caribbean
- ☐ Any other black/African/Caribbean background, write here: ____________

E) Other ethnic group:
- ☐ Arab
- ☐ Any other ethnic group, write here: ____________

PIS part 1 v2 100316

Study of Family Health in Coventry

THE UNIVERSITY OF WARWICK

WARWICK MEDICAL SCHOOL

We invite you to take part in a research study

Before you decide, it is important to know why the research is being done and what it would involve. Please take time to read this information sheet. Talk to others about the study if you wish. One of our team will go through this information sheet with you and answer any questions you have.

Important things that you should know

What is the study about? We would like to know what parents in Coventry think about child health, and in particular health behaviours. This includes what it means to be healthy, the things families do to be healthy and what gets in the way. We are especially interested in how culture, traditions and ethnicity influence the health of families.

Why have I been asked to take part? We are interested in the views of parents who live in Coventry.

What will happen if I take part? A researcher will be in touch to invite you to a group discussion at a local community venue. This will be a small group of around 6 – 8 other parents from the local area and two researchers. You may know some of these people and others may be strangers.

If you would prefer not be part of a group discussion, you can ask for a one-to-one interview between you and a researcher instead.

Do I have to take part? No. The choice to take part is entirely up to you. If you choose to take part, we will ask you to sign a form to confirm this.

You can stop the research at any time without giving a reason. You can also ask to withdraw from the research up to 3 months after taking part in the study. In this case, we will do our best to remove your quotes and stories from any written reports.

What will I have to do?

1. When you arrive you will be asked to sign a form to give your consent
2. As a group, you will be asked questions about your views and experiences on topics related to child health. The meeting will be recorded on an audio-digital recorder
3. Before you leave, you will be asked to complete a short written survey

The meeting will last up to 1 hour and 30 mins. Refreshments will be provided.

What are the possible disadvantages of taking part? You will need to take time out of your day, which may be inconvenient. Some of the topics discussed may be personally sensitive to you or others.

What are the possible benefits of taking part? At the end of the research, we hope to use the findings to support other families in Coventry to be healthy. By taking part in the research, your input will help other families in the future.

How will my data be used? Reports of the research will be written. These will include quotes and stories from you and other parents. These may also be used for teaching purposes.

Your name will not be used in any reports. If the quotes we use include any identifiable information, we will remove or change those parts of your quote, and check this with you first.

Will my personal information be kept private? We will keep information about you very safe and private.

- Your personal information, such as address and phone number, will be kept in a password-protected electronic folder and physical copies in a locked filing cabinet.
- You data will be kept for 5 years, after which it will be disposed of securely.
- Although we will keep your data private, there will be other parents at the meeting, some of whom you may know.

Who is funding the research? The research is funded through the National Institute of Health Research (NIHR). It is part of collaboration between the University of Warwick and local organisations in the West Midlands. You can find out more about the research at:
http://www2.warwick.ac.uk/fac/med/about/centres/clahrc/

Who has reviewed the study? The study has been approved by the Biomedical and Scientific Research Ethics Committee (BSREC) at the University of Warwick.

Thank you for taking the time to read this information. For more information about the study, please contact:

Marie Murphy
(PhD Researcher)
University of Warwick
Marie.murphy@warwick.ac.uk
07725745411

What if I have a problem?

Any complaint about the way you have been dealt with during the study or any possible harm you might have suffered will be addressed seriously. Please address your complaint to the person below, who is a senior University of Warwick official entirely independent of this study:

Director of Delivery Assurance
Registrar's Office
University House
University of Warwick
Coventry
CV4 8UW
Complaints@Warwick.ac.uk
024 7657 4774

If you would like to take part in the study but have a problem that might prevent you from doing so, please contact the researcher using the details at the bottom of this page. This might include access, language, transport or childcare issues.

NHS
National Institute for Health Research

Appendix 24 Study component four: consent form

Consent form part 1 v2 100316

Study of Family Health in Coventry

Participant consent form

THE UNIVERSITY OF WARWICK

WARWICK MEDICAL SCHOOL

Please tick

1. I confirm that I have read and understand the information sheet (dated 10/03/16) for this study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, with no negative consequences. ☐
3. I understand that the information I give will remain confidential and that I will be given anonymity in any research reports. ☐
4. I understand that this interview will be audio recorded. ☐
5. I agree to take part in the above study. ☐

Your name	Date	Signature
Name of researcher	Date	Signature

ID

NHS National Institute for Health Research

Appendix 25 Study component four: semi-structured topic guide

Focus groups and interviews with parents

- Researcher introductions, what to expect from the interview, opportunity to ask questions.
- Explain that the research is exploring children's health and family health, so we are seeking their views as parents.

Topic guide

1. Beliefs and norms

Key questions
1. In turn, please tell the group your name, where you are from and complete the following sentence: *"To me, being healthy means…"* or *"to me, being a healthy child / family means…"* 2. How did you learn what was healthy and unhealthy? How do your children learn about it?
Prompts
• What does a healthy diet look like to you? • What does being physically active mean to you? If mentioned, begin to explore beliefs around weight: • You have mentioned weight – can you explain more? • Is it important to be a 'healthy weight'? • What does a 'healthy weight' mean? • What does an 'unhealthy weight' mean? • Do many children have an unhealthy weight? • If yes, why do you think that is? Who or what is responsible? • Do you think other people in the local area/community think the same? If not mentioned, how about weight? How might a person's weight influence their health?

2. Experiences and influences

Key questions
Explore participants' personal experiences around diet, physical activity and weight relating to their own families • How healthy do you think your family's diet is? How physically active is your family?
Prompts
• How do you think it compares to other families' diets? • Would you say your children eat a typical British diet or do they also eat 'traditional' foods?

3. Factors influencing diet and physical activity

Key questions
• What influences the kinds of foods and drinks you and your family eat?
Prompts
Explore: • Family background and traditions • What is the influence of their parents' background and origins? • Boys and girls - are they different in what they eat and the kind of physical activity they do? • Friends, wider family, community, school government, media etc.? • Cost

4. Opportunities and barriers

Key questions
• What opportunities are there for you and your children to have a healthy diet and be physically active? • What gets in the way of having a healthy diet and being physically active for you and your children?
Prompts
Explore: • Travel • Leisure time • School • Leisure facilities • Local area • Parks and outdoor play • Food shopping • Family dinner times Was your diet similar to this as a child? How active were you as a child? What has changed for children now? How is life different?

5. Motivations and solutions

Key questions
• What would you change about your family's diet and physical activity, if anything? How confident are you that you could do those things? • Do families need support to help them to be healthy? • What would help families to achieve a healthy weight?
Prompts
• Does a healthy lifestyle seem achievable for you and your family? • What would make it easier for your family to be healthy? • What individuals can do? Family and friends? Schools? The wider community? • What can society do? What can the government do? • What would make it easy to be a healthy weight?

6. Summary

• What other things influence your family's ability to eat healthily and be active, that we haven't discussed already? • Do you think other families in the area have the same experiences as you relating to diet and physical activity?
<u>Ranking activity.</u> Ask the focus group assistant to use pieces of card to write the 'influencing factors' and place these in the centre of the circle. Ask each participant in turn to answer the following questions: • Which is the most important factor for you in maintaining a 'healthy weight'? • What influences your family's health the most? OR • What is the one main thing that would help you and your family to be healthy? • What is the one main thing that gets in the way?

Conclude the interview. Thank participants for their time and provide signposting to support information in the PIS.

Appendix 26 Study component four: post-focus group questionnaire

Participant Questionnaire part 1 v1 26/01/16

ID	

Parent Questionnaire

In this questionnaire, you will be asked for basic background information about yourself. These questions are being asked in order that the researcher can gain a better understanding of those taking part in the research. If you are not comfortable answering a question, you can skip it.

Name	
Address	
Postcode	

Please note, your name will not be used in the research, and your details will be kept securely and confidentially.

About you

1. What is your gender?

2. What is your age?

18-25 years	☐	26-34 years	☐	Prefer not to say	☐
35-45 years	☐	46-55 years	☐		
56-65 years	☐	66+ years	☐		

3. What is your highest qualification level?

- ☐ No qualifications
- ☐ GCSE or O Level
- ☐ GCE, A level or similar
- ☐ Vocational (BTEC/NVQ/Diploma)
- ☐ Other (please specify): ____________________
- ☐ Vocational (BTEC/NVQ/Diploma)
- ☐ Degree level or above
- ☐ Prefer not to say

4. In your own words, how would you describe your ethnicity?

5. a) Do you have a religious faith?

Yes ☐ No ☐ Prefer not to say ☐

b) If yes, how would you describe your religious faith?

☐ Christian (any denomination)
☐ Jewish
☐ Muslim
☐ Sikh
☐ Hindu
☐ Buddhist
☐ Other (please specify): ______________________

6. How many children do you have within each age group below?

a) Between 0 – 3 years:

b) Between 4 – 11 years:

c) 12 years and above:

7. Please state the country you were born in.

8. What is your main language(s)?

Family health

9. On a scale of 1 – 5, how healthy is your physical environment? (Please circle)

Not at all	Slightly	Moderately	Very	Extremely
1	2	3	4	5

10. Have any of your children been classified as overweight or obese by a medical professional or through school measurements?

Yes ☐ If yes, how many? ______ No ☐

Not sure ☐ Prefer not to say ☐

Appendix 27 Working joint display synthesis table: Universal findings

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	**Study 1 (Systematic review, QUAN)**	**Study 3 (Child interviews, QUAL)**	**Study 4 (Parent focus groups / interviews, QUAL)**		
Child level						
Age: *Odds of overweight increased across the course of childhood*	**Key findings:** ↑ % overweight in year 6 vs reception: YR = 23%, 95% CIs: 23%-24% Y6 = 35%, 95% CIs: 34%-36 ↑ mean zBMI in year 6 vs reception: YR = 0.34, SD: 1.09 Y6 = 0.52, SD: 1.24 in year 6	**Key finding:** Increases in BMI between 3 – 7 years observed only in Asian and black children, not WB and in girls overall (Martinson *et al.*, 2015)	**Absent:** Sample consisted of one age group only	**Explanation:** *Opportunities* Parents described fewer opportunities for PA as children get older in school, particularly due to a focus on academics over physical activity [explanatory]	Explanatory	Absence
				Explanation: *Independence* Older childhood was viewed as a phase of increasing independence and responsibility in relation to food behaviours, but are negatively influenced by peers' food choices. Some parents felt that independence in food choice resulted in unhealthy choices. [explanatory]	Explanatory	Absence
Gender: *Boys had higher odds of overweight than girls*	**Key findings:** Male gender significantly associated with odds of overweight in year 6 only (OR = 1.16, 95% credible	**Absent:** Only one of the included studies reported prevalence by gender, and the effect differed by ethnic group	**Explanation:** *Body size ideals/image* Two girls made reference to girls' desires to be slim/curvy (n=2) [explanatory]	**Explanation:** *Body size ideals/image* One parent described differential societal pressures for girls' and boys' body shapes.	Explanatory	Partial agreement [study 3 + 4]

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	**Study 1 (Systematic review, QUAN)**	**Study 3 (Child interviews, QUAL)**	**Study 4 (Parent focus groups / interviews, QUAL)**		
	intervals: 1.10,1.22; P<0.001) Boys in both year groups had ↑ prevalence of overweight versus girls (YR=24%; 95% CIs: 24,25 vs 22%; 22,23 and Y6=37%; 36,37 vs 33%; 33,34) Year 6 BMI significantly ↑ in boys vs girls by +0.14 (95% credible intervals: 0.11, 0.17; p<0.001).			Parents reported daughters' desire to be slim and often had to reassure daughters regarding weight (n = 3). [explanatory]		
		Absent: Only one of the included studies reported prevalence by gender, and the effect differed by ethnic group	**Explanation:** *Body size ideals/image* A gender difference in healthy body aesthetic was apparent: boys emphasised muscles & strength (45.5%, n = 5 for boys and 33.3%, n = 5 for girls) [unclear]	**Absent:** did not emerge in data	Explanatory	Absence
School level						
School: *School environment plays minimal role in determining risk of overweight*	**Key findings:** *Fast food environment:* Fast food environment around school not associated with weight	**Absent:** not explored in included studies	**Contradiction:** *Perceived role of fast food environment* Children described a negative influence of the availability of takeaways/takeaway food and junk food in shops, although only one specifically in relation to the after-school period. [contradictory]	**Contradiction:** *Perceived role of fast food environment* Three parents said that their children accessed takeaways with friends/after school, and a number of parents discussed an abundance of fast food outlets in the neighbourhood [contradictory]	Contradictory	Partial agreement [study 3 + 4]
	School-level variation in BMI: the extent to which schools varied was small.	**Absent:** not explored in included studies	**Contradiction:** *Role of school* Children believed that school provides	**Contradiction:** *Role of school* School was seen as an important contributor to	Contradictory	Partial agreement [study 3 + 4]

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	Study 1 (Systematic review, QUAN)	Study 3 (Child interviews, QUAL)	Study 4 (Parent focus groups / interviews, QUAL)		
			opportunities for health education, healthy meals / snacks, and opportunities for PA. PA was enabled by PE, sports teams, and the presence of other children to play with. Teachers positively reinforce healthy behaviours. [contradictory]	children's health behaviours. The school role included health education and information (for children and parents), healthy schools meals provision, space and equipment for play, structured (and free) opportunities for physical activity through PE and after-school clubs and team-sports. Parents had confidence that school meals were healthy and relied on schools to provide all the physical activity children require to be healthy. Some parents were disappointed by school dinners, and some parents felt that it was a problem that children could choose their own food as this would inevitably lead to unhealthy choices. [contradictory]		
	Age and school-level variation in BMI: effect of school stronger in reception year vs year 6.	**Absent:** not explored in included studies	**Absent:** Sample consisted of one age group only	**Explanation:** *Role of school* Parents described fewer opportunities for children to be active in	Explanatory	Absence

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	**Study 1 (Systematic review, QUAN)**	**Study 3 (Child interviews, QUAL)**	**Study 4 (Parent focus groups / interviews, QUAL)**		
	School level variance YR = 0.7% and Y6 = 0.4%			school in later childhood [explanatory]		
Neighbourhood level						
Neighbourhood: *deprivation, safety and crime strongly influence health behaviours*	**Key finding:** ↑ IMD associated with ↑ zBMI and ↑ odds for overweight	**Key finding:** +ve association of IMD with odds of obesity (Townsend *et al.*, 2012)	**Explanation:** *Safety/crime* Anti-social behaviour in parks / bullying / safety concerns restricted physical activity for children [explanatory]	**Explanation:** *Safety/crime* Parents had concerns about anti-social behaviour, road-safety, children getting injured, children falling into bad habits/crowds and children being abused or kidnapped, and a lack of community spirit. This restricted independent, outdoor play. [explanatory]	Explanatory	Partial agreement [study 3 + 4]
			Explanation: *Neighbourhood aesthetics* Children were put-off outdoor physical activity by untidiness / litter and pollution in local area.	**Absent:** did not emerge in parent's data	Explanatory	Absent
			Explanation: *Access/availability (1)* Children felt that a healthy environment was one with limited access to fast food outlets and shops selling junk food [explanatory]	**Explanation:** *Access/availability (1)* Some parents described a high density of fast food outlets near home and felt that this was unhelpful as it made unhealthy choices easier (n=5) [explanatory]	Explanatory	Partial agreement [study 3 + 4]

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	**Study 1 (Systematic review, QUAN)**	**Study 3 (Child interviews, QUAL)**	**Study 4 (Parent focus groups / interviews, QUAL)**		
				Parents felt there was a lack of local affordable leisure facilities [explanatory]		
			Explanation: *Access/availability (2)* Any quiet, traffic-free open space was valued for enabling independent outdoor play [explanatory]	**Explanation:** *Access/availability (2)* Six parents discussed making good use of local parks / green gyms. Two participants from areas of low deprivation talked of living nearby open green space, facilitating outdoor activity. Six parents felt outdoor space was lacking in local environment. [explanatory]	Explanatory	Partial agreement [study 3 + 4]
			Contradiction: *Access/availability (3)* lack of family access to a car facilitates physical activity due to reliance on walking [contradictory]	**Explanation/ Contradiction:** *Access/availability (3)* Some participants from areas of high deprivation described not having use of a car: this facilitated walking but acted as a barrier to transporting children to structured activities. [mixed]	Mixed	Partial agreement [study 3 + 4]

Appendix 28 Working joint display synthesis table: Black African and Caribbean ethnic groups

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	**Study 1 (Systematic review, QUAN)**	**Study 3 (Child interviews, QUAL)**	**Study 4 (Parent focus groups / interviews, QUAL)**		
Child level						
Ethnicity: patterns in weight status dependent upon measure used	**Scenario 1: Children from black ethnic backgrounds had a high risk for overweight versus white British children:** ↑ zBMI and ↑ odds of overweight for BA versus WB, ↑ odds of overweight for BC vs WB, but only for girls	**Key finding:** ↑ % of overweight and/or obesity consistently found in BAC groups, especially the BA group (ranging from 11.1% - 18.7% obese), vs either WB children (5.1% - 5.5% obese) or the general population [agreement with study 2]	**Explanation:** *Body size ideals/image* ↓ % of BA children interpreted a healthy body as a muscly & strong body vs WB. However, caution over interpretation due to small numbers. [Unclear]	**Explanation:** *Body size ideals/image* Cultural valuing of a large body size. Large weight was associated with healthfulness and strength, and was an indication of being well-fed. [explanatory]	Mainly explanatory	Dissonance [study 3 + 4]
		Absent: Not apparent in data	**Absent:** did not emerge in data	**Explanation:** *Hospitality* One BA parent described traditional practice of offering food when people visit your home. This meant that social visits resulted in over-eating. [explanatory]	Explanatory	Absent
		Explanation: *Dietary beliefs/behaviours:* +ve association between child food approach (a combination score of food responsiveness, emotional overeating, enjoyment of food, and desire to drink) and BMI	**Explanation:** *Dietary beliefs/behaviours:* Viewing the occasional treat as part of a healthy diet was particularly the case for BA children vs to other groups [explanatory]	**Explanation:** *Dietary beliefs/behaviours:* Discussion of 'treating' children with foods perceived as less healthy (sweets, pastries, takeaway), even only occasionally, featured in the data of participants	Explanatory	Full agreement

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	Study 1 (Systematic review, QUAN)	Study 3 (Child interviews, QUAL)	Study 4 (Parent focus groups / interviews, QUAL)		
		in BAC only + BAC parents reported significantly ↑ food-approach behaviours in their children (Blissett & Bennett, 2013)[explanatory]		from BAC more prominently vs other ethnic backgrounds [explanatory]		
		Explanation: *Parenting approaches* +ve association between restrictive food practices (i.e. restriction for weight control) and BMI in BAC only (Blissett & Bennett, 2013) [explanatory]	**Absent:** did not emerge in data	**Explanation:** *Parenting approaches* Rule-setting and disciplinary approaches was a common theme in data from BAC participants vs other groups. However, BAC parents & grandparents described feeling limited in disciplining children by legal restrictions and concerns about child protection [explanatory]	Explanatory	Partial agreement [study 1 + 4]
		Absent: Not apparent in data	**Absent:** did not emerge in data	**Explanation:** *Traditional dietary practices:* Some elements of African diets were viewed as unhealthy, for example frying food, an emphasis on meat and an abundance of sugar Parents felt that children had a taste preference for 'British'/fast food (n=7)	Explanatory	Absent

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	Study 1 (Systematic review, QUAN)	Study 3 (Child interviews, QUAL)	Study 4 (Parent focus groups / interviews, QUAL)		
				and exposure to British foods in children's day-to-day lives e.g. at school appeared to undermine efforts to retain traditional dietary practices. [explanatory] *Access to traditional food* Parents from BAC backgrounds reported difficulty in finding traditional African foods in local shops, and the high expense of fresh and organic foods [explanatory]		
		Absent: Not apparent in data	**Absent:** Did not emerge in data	**Explanation:** *Climate* Parents who had migrated to the UK more often described weather and climate as a barrier to PA (discussed by 14 of 21 parents born overseas; and 2 of 12 born in the UK) [explanatory] *Community* Parents felt that a sense of community in Africa supported independent outdoor play	Explanatory	Absent
			Absent:		Explanatory	

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	**Study 1 (Systematic review, QUAN)**	**Study 3 (Child interviews, QUAL)**	**Study 4 (Parent focus groups / interviews, QUAL)**		
		Explanation: *Parental weight* Mothers' BMI explained adiposity in BAC children (Zilanawala *et al.*, 2015)[explanatory]	did not emerge in data	**Explanation:** *Parental weight* Majority of parents providing their ethnicity (or country of origin) as black, African or Caribbean (including Mixed) self-reported weight status as obese/overweight vs not overweight or not stated. Parents described concerns about their own weight or concerns about own or family's health behaviours [explanatory]		Partial agreement [study 1 + 4]
	Scenario 2: black African and Caribbean children have low BMI vs WB: significantly ↓ zBMI for BA vs WB when BMI is adjusted for height or body fat ↓ zBMI for BC vs WB when adjusted for height or body fat	**Key finding:** ↑ % of overweight and/or obesity consistently found in BAC groups, especially the BA group (ranging from 11.1% - 18.7% obese), vs either WB children (5.1% - 5.5% obese) or the general population [disagreement with study 2]	**Explanation:** *Traditional dietary practices* One BA child defined the African diet as inherently healthy. [explanatory] BA children in particular identified 'fast food' or takeaways as unhealthy and considered homemade food as healthy [explanatory]	**Explanation:** *Traditional dietary practices* BAC parents typically described a traditional diet as fresh (food sourced from garden/locally) and homemade (vs British food which was processed). Traditional dietary patterns were described as being based on vegetables (e.g. okra, spinach) and starchy foods (e.g. cassava, yam, rice, semolina, maize, potatoes), organic,	Explanatory	Partial agreement [study 3+4]

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	Study 1 (Systematic review, QUAN)	Study 3 (Child interviews, QUAL)	Study 4 (Parent focus groups / interviews, QUAL)		
				seasonal and home-grown produce and home cooking [explanatory]		
Family & Neighbourhood level						
Markers of parental socioeconomic status and neighbourhood IMD: Positive socioeconomic gradients in health for black African children	**Key finding:** *Deprivation* Inverse relationship between IMD and weight status for BA (↓ zBMI and ↓ odds of overweight as IMD ↑) in reception only (may only be the case in boys)	**Key findings:** *Education* Significant interaction between education & Black ethnicity suggesting protective effect of low education (Brophy *et al.*, 2009; Martinson *et al.*, 2012) *Income* two included studies exploring this variable found high risk of adiposity in high income black/African groups, although this was significant in only one study (Brophy *et al.*, 2009; Martinson *et al.*, 2012) *SES* potential +ve association for socioeconomic class and adiposity for BAC children (relationship most clear using ponderal	**Absent:** themes relating to SES were largely absent from the data	**Explanation:** *Body size ideals/image and tradition* Large weight was an indication of being wealthy and well-fed. **Explanation:** *Life in Africa* One parent described takeaway food in Africa as 'for the rich'. [explanatory] The traditional lifestyle in African countries was described as being incidentally active, with much of this related to hardship e.g. more physically demanding household work, more time spent outdoors, further distances travelled on foot . [explanatory]	Explanatory	Partial agreement [study 1 + 4]

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	Study 1 (Systematic review, QUAN)	Study 3 (Child interviews, QUAL)	Study 4 (Parent focus groups / interviews, QUAL)		
		index) (Thomas *et al.*, 2012)				
		Key finding: *Socioeconomic gradients and migration* Low income was protective for children of foreign-born Black mothers only (Martinson *et al.*, 2012) Interaction between education & Black ethnicity present in native-born mothers only (Martinson *et al.*, 2012)	**Absent:** did not emerge in data	**Explanation:** *Body size/image* Cultural valuing of large body size seen as a traditional viewpoint, parents themselves often did not subscribe to this traditional view point . [explanatory] *Life in Britain* Parents described dietary transitions following migration based on economic capacity, e.g. ↓ consumption of fruit and vegetables due to their expense, higher consumption of 'treat' foods and fast food due to their abundance and low cost. In the UK, healthy foods are expensive (African migrant parents), and treat foods/takeaways are abundant and cheap (African migrant parents).	Explanatory	Partial agreement [study 1 + 4]

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	**Study 1 (Systematic review, QUAN)**	**Study 3 (Child interviews, QUAL)**	**Study 4 (Parent focus groups / interviews, QUAL)**		
				Parents reported poor weather and safety concerns as a barrier to PA. Parents felt that activities and clubs were expensive Participants described a period of adaptation in their new environment, where desire for treat foods declined upon longer stay in UK.		

Appendix 29 Working joint display synthesis table: South Asian ethnic groups

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	**Study 1 (Systematic review, QUAN)**	**Study 3 (Child interviews, QUAL)**	**Study 4 (Parent focus groups / interviews, QUAL)**		
Child level						
Ethnicity: *Weight status patterns dependent upon measure used*	**Scenario 1: Heterogeneity in patterns of weight status within South Asian group:** Indian children generally had ↓ zBMI and ↓ odds of overweight vs WB Older Pakistani children had ↑ odds of overweight vs WB Bangladeshi children had ↑ odds for overweight vs WB	**Key findings:** A high prevalence of overweight and/or obesity in Bangladeshi children in particular (10.7% - 13% obese), and a low prevalence of overweight and/or obesity in Indian children (4.3% - 5% obese), whilst findings in other South Asian groups were largely inconsistent [some agreement with scenario 1]	**Explanation:** *Body size ideals/image* Indian children made greater reference to 'strength' in their definitions of health vs Bangladeshi/Pakistani [explanatory?]	**Contradiction:** *Body size ideals/image* Cultural valuing of a large body size present across Indian & Pakistani [contradictory]	Mixed	Dissonant [study 3 vs 4]
		Absent: not present in systematic review	**Explanation:** *Dietary beliefs/behaviours* Bangladeshi/Pakistani children mentioned a liking for sweets or chocolates, whilst no Indian children did. [explanatory]	**Contradiction:** *Dietary beliefs/behaviours* No difference in responses between Indian & Pakistani parents [contradictory]	Mixed	Dissonant [study 3 vs 4]
		Absent: not present in systematic review	**Absent:** Not apparent in data of South Asian children (Muslim children were from African and Arab backgrounds)	**Explanation:** *Religious commitments* Parents reported commitment to attending mosque in the evening as a practical barrier to children being physically	Explanatory	Absent

Theme	**Key finding**	**Potential explanations / contradictions**			**Explanatory value code**	**Data coherence code**
	Study 2 (NCMP analyses, QUAN)	**Study 1 (Systematic review, QUAN)**	**Study 3 (Child interviews, QUAL)**	**Study 4 (Parent focus groups / interviews, QUAL)**		
				active, since this after-school activity resulted in children being sedentary for a number of hours (Pakistani only). [explanatory]		
		Absent: not present in systematic review	**Absent:** did not emerge in child data	**Contradiction:** *Cultural expectations* SA mothers of Muslim (Indian and Pakistani) faith talked about taboos relating to the perceived ability of girls and women to be physical active in public [contradictory]	Contradictory	Absent
		Explanation: *SES* Socioeconomic status (mother's employment, single parenthood, and socioeconomic position) explained the high odds for obesity in Bangladeshi children (Zilanawala *et al.*, 2015)[explanatory]	**Absent:** children did not discuss aspects of socioeconomic status	**Absent:** although parents discussed barriers related to material disadvantage, this was found universally across all groups	Explanatory	Absent
	Scenario 2: South Asian children have high BMI vs WB: ↑ BMI in children from all South Asian groups vs WB when BMI is adjusted for body fat	**Key findings:** Overall, a low prevalence of overweight & obesity observed in 'Asian' groups ranging from 19.2% (children of foreign born mothers,	**Explanation:** *Body size ideals/image* A lower proportion of South Asian children interpreted a healthy body as a muscly &	**Explanation:** *Body size ideals/image* Cultural valuing of a large body size, particularly girls (both Pakistani). Large weight was associated with	Mainly explanatory	Dissonant [study 3 vs 4]

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	Study 1 (Systematic review, QUAN)	Study 3 (Child interviews, QUAL)	Study 4 (Parent focus groups / interviews, QUAL)		
		aged 7 years) - 27.6% (children of native born mothers aged 5 years). [contradictory] However, when disaggregated groupings were used, fairly large and consistent differences in prevalence across South Asian groups (as detailed above)	strong body vs WB [unclear]	healthfulness, and was an indication of being well-fed. Parents from SA backgrounds in particular discussed their parental preference for their own children to not be too slim or underweight [explanatory]		
		Absent dietary beliefs did not arise in data	**Contradiction:** *Dietary beliefs/behaviours* Describing the negative effects of a high sugar intake was common in children from South Asian backgrounds compared to other groups, although it should be noted that the majority of children doing so attended the same school. [contradictory]	**Contradiction:** *Dietary beliefs/behaviours* Some viewed traditional South Asian dietary patterns as healthy: some SA food was healthy and filling (compared to 'British' foods) e.g. chapattis, lentils, curry, use of spices, spinach [contradictory]	Contradictory	Dissonant
		Absent dietary beliefs did not arise in data	**Absent** dietary beliefs did not arise in data	**Explanation:** *Dietary beliefs/behaviours* Some viewed traditional South Asian dietary patterns as unhealthy:	Explanatory	Absent

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	**Study 1 (Systematic review, QUAN)**	**Study 3 (Child interviews, QUAL)**	**Study 4 (Parent focus groups / interviews, QUAL)**		
				described as unhealthy e.g. frying, use of oil, white flour for chapattis and white rice. [explanatory] However, parents felt that children had a preference for 'British' foods . [explanatory] Some resistance / cynicism from parents to make healthy adaptations to traditional food practices [explanatory]		
Age: *Divergence in patterns of weight status across year groups for South Asian children (older children had high odds of overweight)*	**Key findings:** Older Indian boys ↑ odds of overweight vs WB, younger Indian boys ↓ odds. Younger Pakistani children ↓ odds for overweight vs WB, older Pakistani ↑ odds of overweight. Younger Bangladeshi children ↓ zBMI vs WB (prior to adjustment for body fat), older Bangladeshi children ↑ zBMI.	**Key findings:** One study (longitudinal analyses of MCS) showed increases in BMI across all ethnic groups from 3 to 7 years with steeper increases in Asian children versus white children of native-born mothers, especially for Asian children of native-born mothers (Martinson *et al.*, 2015) [agreement with study 2]	**Explanation:** *Focus on academic attainment* A higher proportion of South Asian children incorporated a 'healthy mind' into interpretations of health, achieved via learning [explanatory?]	**Explanation:** *Focus on academic attainment* South Asian parents in particular described prioritisation of academic commitments over being physical active (although concerns over validity of this findings due to small numbers and potential effect of age of participant's children) [explanatory?]	Explanatory	Partial agreement [study 3 + 4]

Theme	Key finding	Potential explanations / contradictions			Explanatory value code	Data coherence code
	Study 2 (NCMP analyses, QUAN)	**Study 1 (Systematic review, QUAN)**	**Study 3 (Child interviews, QUAL)**	**Study 4 (Parent focus groups / interviews, QUAL)**		
	South Asian groups saw largest increases in zBMI and odds of overweight from reception to Year 6 relative to WB group					
Gender: *Dimorphic weight status patterns by gender for South Asian children (boys had high odds for overweight)*	**Key findings:** older Indian & Pakistani boys ↑ odds of overweight vs WB boys, but not girls. Odds of overweight in older Bangladeshi boys vs WB substantially higher than girls Only Bangladeshi boys had ↑ zBMI vs WB	**Key findings:** British Pakistani boys had a higher prevalence of excess weight vs WB (39% versus 29.9% using UK90 cut-offs) whilst British Pakistani girls had a lower prevalence vs WB (24.4% vs 36.2%) [some agreement with study 2] 2nd gen Pakistani boys had significantly higher odds of overweight vs 3rd gen for BMI and SFT	**Absent:** themes relating to gender within SA group were not apparent	**Contradiction:** *Cultural expectations* SA mothers of Muslim faith talked about taboos relating to the perceived ability of girls and women to be physical active in public [contradictory]	Contradictory	Absent
			Absent: themes relating to gender within SA group were not apparent	**Contradiction:** *Body size ideals/image* Cultural valuing of a large body size, particularly for females. One participant described a cultural viewpoint that being slim reduces fertility. [contradictory]	Contradictory	Absent

Appendix 30 Mapping of findings on to the Six Cs SEM (Harrison *et al.*, 2011b)

Level	Potential contributors to childhood obesity in an ethnically diverse urban population		
Cell	• *Height*[1,2] • *Associations between childhood BMI and body fat*		
	Nutrition-related opportunities, resources and practices	**Activity-related opportunities, resources and practices**	**Personal and relational attributes**
Child	• Perceived risk[3] • Habit formed food preferences/like and dislikes • Nutritional knowledge seeking • Dietary intake • *Autonomy over food choice* / spending money • *Conceptualisations of a healthy diet* • *Nutrition related skills e.g. numeracy, label-reading* • *Attitudes towards food e.g. enjoyment of food* • *Rejection of traditional foods*	• Physical activity • Sedentary behaviour / media use • Sufficient sleep • Sufficient energy • *Sporting ability / competency* • *Resilience to bad weather* • *Physical activity preferences* • *Conceptualisations of PA* • *PA knowledge seeking* • *PA routines*	• Gender • BMI/weight status • Ethnicity • Generation • Body image • Emotional *overeating* • *Self-efficacy / perceived level of control* • *Self-motivation / optimism / prioritisation of health* • *Health conditions*
Family	• Foods available at home • Parent encouragement of healthy eating • Parental nutritional knowledge • Limited parental education • Parental food restrictions • Parental dietary intake • Non-breastfeeding at home • Food traditions, rewards / punishments • Family meal culture */ values* • *Conceptualisations of a healthy diet* • *Parental skills e.g. cooking and shopping behaviours* • *Use of food as a parenting tool* • *Mothers' health behaviours during pregnancy* • *Establishment of healthy eating in infancy* • *Maintenance of traditional food practices* • *Influence of pester power* • *Grandparent behaviours*	• Parental encouragement of child activity • Parental fitness knowledge • Parent activity patterns/preferences • Family media use *& family traditions* • *Conceptualisations of PA* • *Value placed on family activities* • *Value placed on 'downtime'* • *Access to a garden and resources* • *Access to a car* • *Parental attitudes towards bad weather* • *Work-life balance: Parent work schedule vs Family leisure time* • *Caring responsibilities* • *Parent's perceptions of neighbourhood safety* • *Religious commitments* • *Parental attitudes towards academic attainment*	• Parent/sibling interactions • *Experiences of* family health/disease/events • Parent BMI • Family ethnicity • Family SES / income • Maternal mental health • *Resilience to material disadvantage* • *Migration / generation / length of time in UK* • *Experiences prior to migration e.g. rurality, country of origin* • *Parental education* • *Size/age of family members* • *Single parenthood* • *Presence of wider family* • *Perceived risk / parent's prioritisation of obesity* • *Parenting approach/styles* • *Value placed on child as an agent of behaviour change* • *Stress of family life / Fatigue*

Level	Potential contributors to childhood obesity in an ethnically diverse urban population		
			• *Parental attitude towards role of school*
Community	• Availability/proximity to food outlets • Healthy school meals */ school meal variety* • *Access to traditional foods* • *Cost of traditional foods* • *Availability of Halal foods* • *School health promotion programmes* • *Teacher encouragement for healthy eating* • *Peer eating norms / food behaviours / role modelling* • *Community eating norms* • *Community health promotion programmes*	• Access to recreational facilities • Local transportation practices • Crime rates / neighbourhood safety • Local leisure time norms • School activity requirements • *Neighbourhood aesthetics* • *Anti-social behaviour* • *Availability of nearby, safe, traffic-free open space, including parks* • *Friends in neighbourhood* • *Activity offered through Church* • *Teacher encouragement for PA* • *School attitudes towards academic attainment* • *Proximity of schools and infrastructure to home* • *Peer encouragement and role modelling* • *Community activity days* • *Local government priorities/agenda e.g. housing, green space*	• Number of friends • Medical inattention to child obesity • Social marginalisation / *Sense of community* • *Weight-related stigmatisation from peers* • *Neighbourhood deprivation*
Country	• Government funding of nutrition campaigns • Government dietary guidelines *e.g. 5-a-day* • National food economy *e.g. cost of organic food, cost of F&V* • Media healthy eating campaigns *e.g. Chage4life* • Media food marketing • *Government development of health technologies e.g. mobile phone apps* • *In-store food marketing* • *Food taxes / subsidies*	• National recession *e.g. funding cuts to schools and leisure services* • Government funding of exercise campaigns • Transportation infrastructure • Transportation economy */ availability of personal transport* • *Manual labour market* • *Technological advancement within home* • *Government housing agenda*	• Media body portrayals */ Social valuing of a healthy weight* • Media health/disease portrayals */ Social valuing of healthy behaviours* • *Prioritisation of health (interaction between government and industry)* • *Guidelines for identification of adiposity*
Culture	• Cultural values towards food-related technology / *Attitudes towards food processing* • Gender-role expectations concerning eating *& food preparation* • *'Grow your own' culture* • Cultural norms for eating out	• *Gendered* norms for exercise in public • Leisure norms • *Access to/attendance at faith centres* • *Attitudes towards car use* • *Conceptualisations of physical activity* • *Gendered conceptualisations of physical activity*	• *Gendered* cultural beauty standards and myths • *Weight-related politeness norms* • *Gendered influence of parental BMI* • *Historical valuing of large body size* • *Stigmatisation of large weight* • *Gendered conceptualisations of parental roles*

Level	Potential contributors to childhood obesity in an ethnically diverse urban population		
	• *Food-related* politeness norms • Special occasion eating practices*/The role of food in hospitality / symbolic nature of food* • *Status given to traditional foods* • *Status given to 'treat foods' / Historical experiences of food hardship* • *Cultural food practices e.g. 'fast food culture'* • *Group food & eating norms* • *Food-related generational conflict* • *Trust in food industry* • *TV cookery shows*	• *Conceptualisations of the home /Valuing of sedentary behaviours* • *Use of TV for fitness e.g. YouTube*	• *Parenting approaches / Attitudes towards child discipline* • *Cultural attitudes towards work / life balance* • *Interaction between food and sedentary behaviours*
Interactions	Ethnicity interacts with: • *Attitudes towards food e.g. enjoyment of food* • Parental food restrictions • *Access to traditional foods* • *Cost of traditional foods* • *Availability of Halal foods* • *Community eating norms* • Gender-role expectations concerning eating *& food preparation* • *'Grow your own' culture* • Cultural norms for eating out • *Food-related* politeness norms • Special occasion eating practices*/The role of food in hospitality / symbolic nature of food* • *Status given to traditional foods* • *Cultural food practices e.g. 'fast food culture'* • *Group food & eating norms* Generation/migration interacts with: • Habit formed food preferences • *Rejection of traditional foods/ Maintenance of traditional food practices* • Parental dietary intake • Family meal culture/*values* • *Grandparent behaviours*	Ethnicity interacts with: • Sufficient sleep • *Religious commitments* • *Parental attitudes towards academic attainment* • *Activity offered through Church* • *Gendered* norms for exercise in public • *Access to/attendance at faith centres* • *Gendered conceptualisations of physical activity* Generation/migration interacts with: • Parent activity patterns/preferences • *Parental attitudes towards bad weather* • *Work-life balance: Parent work schedule vs Family leisure time* • Local transportation practices • Crime rates / neighbourhood safety • Local leisure time norms • *Availability of nearby, safe, traffic-free open space, including parks* • *Friends in neighbourhood* • Transportation infrastructure • Transportation economy */ availability of personal transport* • *Manual labour market* • *Technological advancement within home*	Ethnicity interacts with: • Height • Associations between childhood BMI and body fat • Gender • BMI/weight status • *Migration / generation / length of time in UK* • Emotional *overeating* • Parent BMI • Family SES / income • *Parental education* • *Presence of wider family* • *Parenting approach/styles* • *Neighbourhood deprivation* • *Guidelines for identification of adiposity* • *Gendered* cultural beauty standards and myths • *Weight-related politeness norms* • *Gendered influence of parental BMI* • *Stigmatisation of large weight* • *Gendered conceptualisations of parental roles* • *Parenting approaches / Attitudes towards child discipline* Generation/migration interacts with: • Family SES / income

Level	Potential contributors to childhood obesity in an ethnically diverse urban population		
	• National food economy *e.g. cost of organic food, cost of F&V* • Cultural values towards food-related technology / *Attitudes towards food processing* • *'Grow your own' culture* • Cultural norms for eating out • Special occasion eating practices/*The role of food in hospitality / symbolic nature of food* • *Status given to traditional foods* • *Status given to 'treat foods' / Historical experiences of food hardship* • *Cultural food practices e.g. 'fast food culture'* • *Food-related generational conflict* • *Trust in food industry*	• Leisure norms • *Attitudes towards car use* • *Conceptualisations of physical activity* • *Conceptualisations of the home /Valuing of sedentary behaviours*	• *Experiences prior to migration e.g. rurality, country of origin* • <u>*Parental education*</u> • Social marginalisation / *Sense of community* • *Gendered* cultural beauty standards and myths • *Weight-related politeness norms* • *Gendered influence of parental BMI* • *Historical valuing of large body size* • *Stigmatisation of large weight* • *Parenting approaches / Attitudes towards child discipline* • *Cultural attitudes towards work / life balance*
Time	• *Time spent in UK: Acculturation related to nutrition transition*	• *Time spent in UK: Acculturation related to physical activity transition*	• *Child life course: Age & age related abilities* • *Time spent in UK: Acculturation resulting in a transition in body size ideals* • *Time spent in UK: Changes in access to material resources* • *Changes in society at large: Nostalgia for past/childhood* • *Changes in society at large: The overwhelming influence of modern life*

[1]Italics indicate findings that the current study adds to the existing model.
[2]Underlining indicates significant associations between a variable and weight status as identified through quantitative investigation (the systematic review and analysis of quantitative data)
[3]Not underlined refers to perspectives and experiences that potentially act as contributors to weight status as identified through qualitative exploration (qualitative research with children and parents).

List of references

Acheson, D. (1998) *Inequalities in health: report of an independent inquiry*. London: HMSO.

Adab, P., Pallan, M. J., Cade, J., Ekelund, U., Barrett, T., Daley, A., Deeks, J., Duda, J., Gill, P., Parry, J., Bhopal, R. & Cheng, K. K. (2014) Preventing childhood obesity, phase II feasibility study focusing on South Asians: BEACHeS. *BMJ Open*, 4 (4): 1-12.

Adab, P., Pallan, M. J., Lancashire, E. R., Hemming, K., Frew, E., Barrett, T., Bhopal, R., Cade, J. E., Canaway, A., Clarke, J. L., Daley, A., Deeks, J. J., Duda, J. L., Ekelund, U., Gill, P., Griffin, T., McGee, E., Hurley, K., Martin, J., Parry, J., Passmore, S. & Cheng, K. K. (2018) Effectiveness of a childhood obesity prevention programme delivered through schools, targeting 6 and 7 year olds: cluster randomised controlled trial (WAVES study). *BMJ*, 360

Adair, L. S. & Gordon-Larsen, P. (2001) Maturational timing and overweight prevalence in US adolescent girls. *American Journal of Public Health*, 91 (4): 642-644.

Adams, J., Mytton, O., White, M. & Monsivais, P. (2016) Why Are Some Population Interventions for Diet and Obesity More Equitable and Effective Than Others? The Role of Individual Agency. *PLoS Medicine*, 13 (4): e1001990.

Adamson, J. & Donovan, J. L. (2002) Research in Black and White. *Qualitative Health Research*, 12 (6): 816-825.

Ajzen, I. (1991) The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50 (2): 179-211.

Alexander, D. S., Alfonso, M. L. & Hansen, A. R. (2015) Childhood Obesity Perceptions Among African American Caregivers in a Rural Georgia Community: A Mixed Methods Approach. *Journal of Community Health*, 40 (2): 367-378.

Alidu, L. & Grunfeld, E. A. (2017) A systematic review of acculturation, obesity and health behaviours among migrants to high-income countries. *Psychology & Health*, 1-22.

Ambrosini, G. L., Emmett, P. M., Northstone, K., Howe, L. D., Tilling, K. & Jebb, S. A. (2012) Identification of a dietary pattern prospectively associated with increased adiposity during childhood and adolescence. *International Journal of Obesity (London)*, 36 (10): 1299-1305.

Amenyah, S. D. & Michels, N. (2016) Body size ideals, beliefs and dissatisfaction in Ghanaian adolescents: sociodemographic determinants and intercorrelations. *Public Health*, 139 112-120.

Andersen, A., Krølner, R., Currie, C., Dallago, L., Due, P., Richter, M., Örkényi, Á. & Holstein, B. E. (2008) High agreement on family affluence between children's and parents' reports: international study of 11-year-old children. *Journal of Epidemiology and Community Health*, 62 (12): 1092-1094.

Angell, C., Alexander, J. & Hunt, J. A. (2014) 'Draw, write and tell': A literature review and methodological development on the 'draw and write' research method. *Journal of Early Childhood Research*, 13 (1): 17-28.

Arenz, S., Ruckerl, R., Koletzko, B. & von Kries, R. (2004) Breast-feeding and childhood obesity - a systematic review. *International Journal of Obesity and Related Metabolic Disorders*, 28 (10): 1247-1256.

Arshad, S. (2007) Ethnicity and attitudes to body shape. Doctor of Clinical Psychology Thesis. The University of Leeds.

Backett-Milburn, K., Cunningham-Burley, S. & Davis, J. (2003) Contrasting lives, contrasting views? understandings of health inequalities from children in differing social circumstances. *Social Science & Medicine*, 57 (4): 613-623.

Backett-Milburn, K. & McKie, L. (1999) A critical appraisal of the draw and write technique. *Health Education Research*, 14 (3): 387-398.

Backett, K. & Alexander, H. (1991) Talking to young children about health: methods and findings. *Health Education Journal*, 50 (1): 34-38.

Bakker, L. E., Boon, M. R., van der Linden, R. A., Arias-Bouda, L. P., van Klinken, J. B., Smit, F., Verberne, H. J., Jukema, J. W., Tamsma, J. T., Havekes, L. M., van Marken Lichtenbelt, W. D., Jazet, I. M. & Rensen, P. C. (2014) Brown adipose tissue volume in healthy lean south Asian adults compared with white Caucasians: a prospective, case-controlled observational study. *The Lancet Diabetes & Endocrinology*, 2 (3): 210-217.

Barbour, R. S. (1999) The case for combining qualitative and quantitative approaches in health services research. *Journal of Health Services Research and Policy*, 4 (1): 39-43.

Barkley, J. E., Salvy, S. J., Sanders, G. J., Dey, S., Von Carlowitz, K. P. & Williamson, M. L. (2014) Peer influence and physical activity behavior in young children: an experimental study. *Journal of Physical Activity and Health*, 11 (2): 404-409.

Bazeley, P. (2018) *Integrating analyses in mixed methods research*. London: SAGE Publications Ltd.

Beets, M. W., Banda, J. A., Erwin, H. E. & Beighle, A. (2011) A pictorial view of the physical activity socialization of young adolescents outside of school. *Research Quarterly for Exercise and Sport*, 82 (4): 769-778.

Berge, J. M., Trofholz, A., Tate, A. D., Beebe, M., Fertig, A., Miner, M. H., Crow, S., Culhane-Pera, K. A., Pergament, S. & Neumark-Sztainer, D. (2017) Examining unanswered questions about the home environment and childhood obesity disparities using an incremental, mixed-methods, longitudinal study design: The Family Matters study. *Contemporary Clinical Trials*, 62: 61-76.

Bhatnagar, P., Shaw, A. & Foster, C. (2015) Generational differences in the physical activity of UK South Asians: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, 12 (1): 96.

Bhatnagar, P., Townsend, N., Shaw, A. & Foster, C. (2016) The physical activity profiles of South Asian ethnic groups in England. *Journal of Epidemiology and Community Health*, 70 (6): 602-608.

Bhopal, R. (2004) Glossary of terms relating to ethnicity and race: for reflection and debate. *Journal of Epidemiology and Community Health*, 58 (6): 441-445.

Bhopal, R., Unwin, N., White, M., Yallop, J., Walker, L., Alberti, K. G. M. M., Harland, J., Patel, S., Ahmad, N., Turner, C., Watson, B., Kaur, D., Kulkarni, A., Laker, M. & Tavridou, A. (1999) Heterogeneity of coronary heart disease risk factors in Indian, Pakistani, Bangladeshi, and European origin populations: cross sectional study. *BMJ*, 319 (7204): 215-220.

Bhopal, R. S. (2014) *Migration, ethnicity, race, and health in multicultural societies.* 2nd edn. Oxford: Oxford University Press.

Biddle, S. J. H., Atkin, A. J., Cavill, N. & Foster, C. (2011) Correlates of physical activity in youth: a review of quantitative systematic reviews. *International Review of Sport and Exercise Psychology*, 4 (1): 25-49.

Bilinski, H. N., Duggleby, W. & Rennie, D. (2010) The Meaning of Health in Rural Children: A Mixed Methods Approach. *Western Journal of Nursing Research*, 32 (7): 949-966.

Blissett, J. & Bennett, C. (2013) Cultural differences in parental feeding practices and children's eating behaviours and their relationships with child BMI: a comparison of Black Afro-Caribbean, White British and White German samples. *European Journal of Clinical Nutrition*, 67 (2): 180-184.

Brannen, J. (1992) *Mixing methods: Qualitative and quantitative research*. London: Avebury.

Bronfenbrenner, U. (1979) *The ecology of human development*. Cambridge, Massachusetts: Harvard University Press.

Bronfenbrenner, U. & Morris, P. A. (2006) *The bioecological model of human development*. Hoboken, NJ, US: Wiley Online Library.

Brophy-Herb, H. E., Horodynski, M., Contreras, D., Kerver, J., Kaciroti, N., Stein, M., Lee, H. J., Motz, B., Hebert, S., Prine, E., Gardiner, C., Van Egeren, L. A. & Lumeng, J. C. (2017) Effectiveness of differing levels of support for family meals on obesity prevention among head start preschoolers: the simply dinner study. *BMC Public Health*, 17 (1): 184.

Brophy, S., Cooksey, R., Gravenor, M. B., Mistry, R., Thomas, N., Lyons, R. A. & Williams, R. (2009) Risk factors for childhood obesity at age 5: analysis of the millennium cohort study. *BMC Public Health*, 9: 467.

Brophy, S., Crowley, A., Mistry, R., Hill, R., Choudhury, S., Thomas, N. E. & Rapport, F. (2011) Recommendations to improve physical activity among teenagers--a qualitative study with ethnic minority and European teenagers. *BMC Public Health*, 11: 412.

Brown, T., Smith, S., Bhopal, R., Kasim, A. & Summerbell, C. (2015) Diet and Physical Activity Interventions to Prevent or Treat Obesity in South Asian Children and Adults: A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*, 12 (1): 566-594.

Browne, W. J. (2016) *MCMC Estimation in MLwiN, v2.36*. University of Bristol: Centre for Multilevel Modelling.

Brunton, G., Thomas, J., Harden, A., Rees, R., Kavanagh, J., Oliver, S., Shepherd, J. & Oakley, A. (2005) Promoting physical activity amongst children outside of physical education classes: a systematic review integrating intervention studies and qualitative studies. *Health Education Journal*, 64 (4): 323-338.

Bryman, A. (2007) Barriers to integrating quantitative and qualitative research. *Journal of Mixed Methods Research*, 1(1): 8-22.

Budd, G. M., Mariotti, M., Graff, D. & Falkenstein, K. (2011) Health care professionals' attitudes about obesity: An integrative review. *Applied Nursing Research*, 24 (3): 127-137.

Burton, J., Nandi, A. & Platt, L. (2010) Measuring ethnicity: challenges and opportunities for survey research. *Ethnic and Racial Studies*, 33 (6): 1332-1349.

Bush, H., Williams, R., Bradby, H., Anderson, A. & Lean, M. (1998) Family Hospitality and Ethnic Tradition Among South Asian, Italian and General Population Women in the West of Scotland. *Sociology of Health & Illness*, 20 (3): 351-380.

Butland, B., Jebb, S., Kopelman, P., McPherson, K., Thomas, S., Mardell, J. & Parry, V. (2007) *Foresight. Tackling Obesities: Future Choices - Project Report*. London: The Stationary Office.

Campbell, M. W., Williams, J., Hampton, A. & Wake, M. (2006) Maternal concern and perceptions of overweight in Australian preschool-aged children. *The Medical Journal of Australia*, 184 (6): 274-277.

Cappuccio, F. P., Taggart, F. M., Kandala, N.-B., Currie, A., Peile, E., Stranges, S. & Miller, M. A. (2008) Meta-Analysis of Short Sleep Duration and Obesity in Children and Adults. *Sleep*, 31 (5): 619-626.

Carlin, A., Perchoux, C., Puggina, A., Aleksovska, K., Buck, C., Burns, C., Cardon, G., Chantal, S., Ciarapica, D., Condello, G., Coppinger, T., Cortis, C., D'Haese, S., De Craemer, M., Di Blasio, A., Hansen, S., Iacoviello, L., Issartel, J., Izzicupo, P., Jaeschke, L., Kanning, M., Kennedy, A., Lakerveld, J., Chun Man Ling, F., Luzak, A., Napolitano, G., Nazare, J.-A., Pischon, T., Polito, A., Sannella, A., Schulz, H., Sohun, R., Steinbrecher, A., Schlicht, W., Ricciardi, W., MacDonncha, C., Capranica, L. & Boccia, S. (2017) A life course examination of the physical environmental determinants of physical activity behaviour: A "Determinants of Diet and Physical Activity" (DEDIPAC) umbrella systematic literature review. *PLoS One*, 12 (8): e0182083.

Castles, S., De Haas, H. & Miller, M. J. (2014) *The age of migration. International population movements in the modern world.* 5th edn. Hampshire: Palgrave Macmillan.

Cetateanu, A. & Jones, A. (2014) Understanding the relationship between food environments, deprivation and childhood overweight and obesity: evidence from a cross sectional England-wide study. *Health & Place*, 27 68-76.

Children and Young People's Unit (2001) *Learning to Listen Core Principles for the Involvement of Children and Young People*. Nottinghamshire: DfES.

Clark, T. (2011) Gaining and Maintaining Access:Exploring the Mechanisms that Support and Challenge the Relationship between Gatekeepers and Researchers. *Qualitative Social Work*, 10 (4): 485-502.

Clarke, J., Fletcher, B., Lancashire, E., Pallan, M. & Adab, P. (2013) The views of stakeholders on the role of the primary school in preventing childhood obesity: a qualitative systematic review. *Obesity Reviews*, 14 (12): 975-988.

Clarke, J. L., Griffin, T. L., Lancashire, E. R., Adab, P., Parry, J. M. & Pallan, M. J. (2015) Parent and child perceptions of school-based obesity prevention in England: a qualitative study. *BMC Public Health*, 15: 1224.

Cole, T. J. (1986) Weight/heightp compared to weight/height2 for assessing adiposity in childhood: influence of age and bone age on p during puberty. *Annals of Human Biology*, 13 (5): 433-451.

Cole, T. J. (1990) The LMS method for constructing normalized growth standards. *European Journal of Clinical Nutrition*, 44 (1): 45-60.

Cole, T. J., Bellizzi, M. C., Flegal, K. M. & Dietz, W. H. (2000) Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ*, 320 (7244): 1240.

Cole, T. J., Flegal, K. M., Nicholls, D. & Jackson, A. A. (2007) Body mass index cut offs to define thinness in children and adolescents: international survey. *BMJ*, 335 (7612): 194.

Cole, T. J., Freeman, J. V. & Preece, M. A. (1995) Body mass index reference curves for the UK, 1990. *Archives of Disease in Childhood*, 73 (1): 25-29.

Cole, T. J., Freeman, J. V. & Preece, M. A. (1998) British 1990 growth reference centiles for weight, height, body mass index and head circumference fitted by maximum penalized likelihood. *Statistics in Medicine*, 17 (4): 407-429.

Cole, T. J. & Green, P. J. (1992) Smoothing reference centile curves: The lms method and penalized likelihood. *Statistics in Medicine*, 11 (10): 1305-1319.

Commission on Ending Childhood Obesity (2015) *Interim Report of the Commission on Ending Childhood Obesity*. Geneva: World Health Organization.

Commission on Social Determinants of Health (2008) *Closing the gap in a generation: health equity through action on the social determinants of health. Final Report of the Commission on Social Determinants of Health.* Geneva: World Health Organization.

Conolly, A. (2016) *Health Survey for England 2015 Children's body mass index, overweight and obesity* Leeds: NHS Digital.

Contrada, R. J., Ashmore, R. D., Gary, M. L., Coups, E., Egeth, J. D., Sewell, A., Ewell, K., Goyal, T. M. & Chasse, V. (2000) Ethnicity-Related Sources of

Stress and Their Effects on Well-Being. *Current Directions in Psychological Science*, 9 (4): 136-139.

Costanzo, P. R. & Woody, E. Z. (1985) Domain-Specific Parenting Styles and Their Impact on the Child's Development of Particular Deviance: The Example of Obesity Proneness. *Journal of Social and Clinical Psychology*, 3 (4): 425-445.

Costigan, S. A., Barnett, L., Plotnikoff, R. C. & Lubans, D. R. (2013) The Health Indicators Associated With Screen-Based Sedentary Behavior Among Adolescent Girls: A Systematic Review. *Journal of Adolescent Health*, 52 (4): 382-392.

Coventry City Council (2008) *Greenspace strategy 2008 - 2018*. [online] Available from: http://www.coventry.gov.uk/downloads/file/2298/green_space_strategy (Accessed 30th January 2018).

Coventry City Council (2015) *Equality Factsheet 6. Coventry People and... Race and Ethnicity*. Coventry: Coventry City Council.

Coventry City Council (2016a) *Coventry Headline Statistics*. [online] Available from: http://www.coventry.gov.uk/downloads/9/local_information_and_statistics (Accessed 24th October 2018).

Coventry City Council (2016b) *IMD Decile radar chart*. [online] Available from: http://ias.coventry.gov.uk/IAS/dataviews/view?viewId=236 (Accessed 19th October 2016).

Coventry City Council (2016c) *2011 Census KS201EW – % Non-white ethnic group*. [online] Available from: http://ias.coventry.gov.uk/IAS/dataviews (Accessed 19th October 2016).

Coventry City Council (2016d) *Shape Up Coventry. The urgency of promoting healthy weight among children and young people. Director of Public Health Annual Report 2016.* Coventry: Coventry City Council.

Coventry City Council (2018) *Health inequalities in Coventry - a summary*. [online] Available from: http://www.coventry.gov.uk/downloads/file/27141/health_inequalities_in_coventry_-_a_summary (Accessed 27th April 2018).

Coventry Health and Wellbeing (2016) *Coventry Joint Strategic Needs Assessment 2016*. Coventry: Coventry Health and Wellbeing.

Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I. & Petticrew, M. (2008) Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ*, 337: a1655.

Craig, R. & Mindell, J. (2014) *Health Survey for England 2013: Health, social care and lifestyles.* Leeds: Health and Social Care Information Centre.

Creswell, J. W. & Plano Clark, V. L. (2011) *Designing and conducting mixed methods research*. 2nd edn. Thousand Oaks, CA: SAGE.

Cross-Bardell, L., George, T., Bhoday, M., Tuomainen, H., Qureshi, N. & Kai, J. (2015) Perspectives on enhancing physical activity and diet for health promotion among at-risk urban UK South Asian communities: a qualitative study. *BMJ Open*, 5 (2): e007317.

Crozier, G. (2009) South Asian Parents' Aspirations Versus Teachers' Expectations in the United Kingdom. *Theory Into Practice*, 48 (4): 290-296.

Curry, L. & Nunez-Smith, M. (2015) *Mixed methods in health sciences research. A practical primer.* Thousand Oaks, California: SAGE Publications Ltd.

Dahlgren, G. & Whitehead, M. (2007) *European strategies for tackling social inequities in health: levelling up, Part 2*. Copenhagen: WHO Regional Office for Europe.

Daniels, S. R., Khoury, P. R. & Morrison, J. A. (1997) The utility of body mass index as a measure of body fatness in children and adolescents: differences by race and gender. *Pediatrics*, 99 (6): 804-807.

Daniels, S. R., Khoury, P. R. & Morrison, J. A. (2000) Utility of different measures of body fat distribution in children and adolescents. *American Journal of Epidemiology*, 152 (12): 1179-1184.

Davey, C. (2010) *Children's participation in decision-making. A Summary Report on progress made up to 2010* London: Participation Works.

Davidson, E. M., Liu, J. J., Bhopal, R., White, M., Johnson, M. R. D., Netto, G., Wabnitz, C. & Sheikh, A. (2013) Behavior Change Interventions to Improve the Health of Racial and Ethnic Minority Populations: A Tool Kit of Adaptation Approaches. *The Milbank Quarterly*, 91 (4): 811-851.

Davison, K. K. & Birch, L. L. (2001) Childhood overweight: a contextual model and recommendations for future research. *Obesity Reviews*, 2 (3): 159-171.

Davison, K. K., Gicevic, S., Aftosmes-Tobio, A., Ganter, C., Simon, C. L., Newlan, S. & Manganello, J. A. (2016) Fathers' Representation in Observational Studies on Parenting and Childhood Obesity: A Systematic Review and Content Analysis. *American Journal of Public Health*, 106 (11): e14-e21.

Davison, K. K., Jurkowski, J. M. & Lawson, H. A. (2013) Reframing family-centred obesity prevention using the Family Ecological Model. *Public Health Nutrition*, 16 (10): 1861-1869.

Delavari, M., Sønderlund, A. L., Swinburn, B., Mellor, D. & Renzaho, A. (2013) Acculturation and obesity among migrant populations in high income countries – a systematic review. *BMC Public Health*, 13 (1): 458.

Department for Communities and Local Government (2015) *The English Indices of Deprivation 2015*. [online] Available from: https://www.gov.uk/government/publications/english-indices-of-deprivation-2010 (Accessed 8th November 2016).

Department of Health (2004) *Choosing health: Making healthier choices easier*. London: The Stationery Office.

Department of Health (2008) *Healthy weight, healthy lives: Consumer insight summary*. London: Department of Health.

Department of Health (2011) *Healthy Lives, Healthy People: A call to action on obesity in England.* London: HM Government.

Department of Health and Social Security (1980) *Inequalities in health: report of a Research Working Group Chaired by Sir Douglas Black*. London: Department of Health and Social Security.

Devakumar, D., Grijalva-Eternod, C., Cortina-Borja, M., Williams, J., Fewtrell, M. & Wells, J. (2016) Disentangling the associations between parental BMI and offspring body composition using the four-component model. *American Journal of Human Biology*, 28 (4): 524-533.

Dinsa, G. D., Goryakin, Y., Fumagalli, E. & Suhrcke, M. (2012) Obesity and socioeconomic status in developing countries: a systematic review. *Obesity Reviews*, 13 (11): 1067-1079.

Dinsdale, H., Hancock, C. & Rutter, H. (2014) *National Child Measurement Programme: Changes in children's body mass index between 2006/07 and 2012/13.* London: Public Health England.

Dinsdale, H. & Ridler, C. (2010) *National Child Measurement Programme: Changes in children's body mass index between 2006/07 and 2008/09.* Oxford: National Obesity Observatory.

Dinsdale, H. & Ridler, C. (2012) *National Child Measurement Programme 2010/11: Guidance for analysis.* Oxford: National Obesity Observatory.

Dinsdale, H., Ridler, C. & Rutter, H. (2011) *National Child Measurement Programme: Changes in children's body mass index between 2006/07 and 2009/10.* Oxford: National Obesity Observatory.

Dinsdale, H., Ridler, C. & Rutter, H. (2012) *National Child Measurement Programme: Changes in children's body mass index between 2006/07 and 2010/11.* Oxford: National Obesity Observatory.

Dogra, S. & Barber, S. (2018) 1.4-O4 Islamic religious settings for health promotion activities: an ethnographic exploration of the embodiment of migration, health, ethnicity and religion among South Asian Muslims in the UK, using childhood obesity as a case study. *European Journal of Public Health*, 28 (suppl_1): cky047.027-cky047.027.

Duncan, C., Jones, K. & Moon, G. (1996) Health-related behaviour in context: a multilevel modelling approach. *Social Science & Medicine*, 42 (6): 817-830.

Duran-Tauleria, E., Rona, R. J. & Chinn, S. (1995) Factors associated with weight for height and skinfold thickness in British children. *Journal of Epidemiology and Community Health*, 49 (5): 466-473.

Dwyer, S. C. & Buckle, J. L. (2009) The Space Between: On Being an Insider-Outsider in Qualitative Research. *International Journal of Qualitative Methods*, 8 (1): 54-63.

Edwardson, C. L. & Gorely, T. (2010) Parental influences on different types and intensities of physical activity in youth: A systematic review. *Psychology of Sport and Exercise*, 11 (6): 522-535.

Egan, K. B., Ettinger, A. S. & Bracken, M. B. (2013) Childhood body mass index and subsequent physician-diagnosed asthma: a systematic review and meta-analysis of prospective cohort studies. *BMC Pediatrics*, 13 121.

El-Sayed, A. M., Scarborough, P. & Galea, S. (2011) Ethnic inequalities in obesity among children and adults in the UK: a systematic review of the literature. *Obesity Reviews*, 12 (5): e516-534.

El-Sayed, A. M., Scarborough, P. & Galea, S. (2012) Socioeconomic inequalities in childhood obesity in the United Kingdom: a systematic review of the literature. *Obesity Facts*, 5 (5): 671-692.

Emmett, P. M. & Jones, L. R. (2015) Diet, growth, and obesity development throughout childhood in the Avon Longitudinal Study of Parents and Children. *Nutrition Reviews*, 73 (suppl_3): 175-206.

Eyre, E. (2014) Environmental influences on physical activity and weight status in children from deprived multi-ethnic backgrounds in Coventry. Doctor of Philosophy Thesis. Coventry University.

Eyre, E., Cox, V., Birch, S. & Duncan, M. (2015a) Parental perspectives on the influence of obesogenic environments on physical activity in children insfrom deprived areas. *Appetite*, 87: 385.

Eyre, E., Duncan, M., Birch, S. & Cox, V. (2014) Low socio-economic environmental determinants of children's physical activity in Coventry, UK: A qualitative study in parents. *Preventive medicine reports*, 1 32-42.

Eyre, E. L., Duncan, M. J., Birch, S. L. & Cox, V. (2015b) Environmental and school influences on physical activity in South Asian children from low socio-economic backgrounds: A qualitative study. *Journal of Child Health Care*, 19 (3): 345-358.

Eyre, E. L., Duncan, M. J., Smith, E. C. & Matyka, K. A. (2013) Objectively measured patterns of physical activity in primary school children in Coventry: the influence of ethnicity. *Diabetic Medicine*, 30 (8): 939-945.

Eyre, E. L. J. & Duncan, M. J. (2013) The Impact of Ethnicity on Objectively Measured Physical Activity in Children. *ISRN Obesity*, 2013: 757431.

Eyre, E. L. J., Duncan, M. J., Birch, S. L., Cox, V. & Blackett, M. (2015c) Physical activity patterns of ethnic children from low socio-economic environments within the UK. *Journal of Sports Sciences*, 33 (3): 232-242.

Faherty, G. & Gaulton, L. (2016) Working together to reduce health inequalities in the Marmot City of Coventry. *Primary Health Care*, 27 (2): 26-29.

Falconer, C. L., Park, M. H., Croker, H., Kessel, A. S., Saxena, S., Viner, R. M. & Kinra, S. (2014a) Can the relationship between ethnicity and obesity-related behaviours among school-aged children be explained by deprivation? A cross-sectional study. *BMJ Open*, 4 (1): doi: 10.1136/bmjopen-2013-003949.

Falconer, C. L., Park, M. H., Croker, H., Skow, Á., Black, J., Saxena, S., Kessel, A. S., Karlsen, S., Morris, S., Viner, R. M. & Kinra, S. (2014b) The benefits and harms of providing parents with weight feedback as part of the national child measurement programme: a prospective cohort study. *BMC Public Health*, 14 (1): 549.

Farley, T. A., Meriwether, R. A., Baker, E. T., Watkins, L. T., Johnson, C. C. & Webber, L. S. (2007) Safe Play Spaces To Promote Physical Activity in Inner-City Children: Results from a Pilot Study of an Environmental Intervention. *American Journal of Public Health*, 97 (9): 1625-1631.

Faulkner, G. E. J., Buliung, R. N., Flora, P. K. & Fusco, C. (2009) Active school transport, physical activity levels and body weight of children and youth: A systematic review. *Preventative Medicine*, 48 (1): 3-8.

Fetters, M. D., Curry, L. A. & Creswell, J. W. (2013) Achieving Integration in Mixed Methods Designs—Principles and Practices. *Health Services Research*, 48 (6 Pt 2): 2134-2156.

Fetters, M. D. & Freshwater, D. (2015) The 1 + 1 = 3 Integration Challenge. *Journal of Mixed Methods Research*, 9 (2): 115-117.

Fielding, N. G. (2012) Triangulation and Mixed Methods Designs:Data Integration With New Research Technologies. *Journal of Mixed Methods Research*, 6 (2): 124-136.

Fielding, N. G. & Fielding, J. L. (1986) *Linking data*. London: SAGE.

Fitzpatrick, K. R. (2016) Points of Convergence in Music Education:The Use of Data Labels as a Strategy for Mixed Methods Integration. *Journal of Mixed Methods Research*, 10 (3): 273-291.

Fitzsimons, E. & Pongiglione, B. (2017) *Prevalence and trends in overweight and obesity in childhood and adolescence Findings from the Millennium Cohort Study, with a focus on age 14*. London: Centre for Longitudinal Studies.

Food Standards Agency (2018) *Food Hygiene Rating Scheme*. [online] Available from: https://www.food.gov.uk/safety-hygiene/food-hygiene-rating-scheme (Accessed 24th May 2018).

Fraser, L. K., Edwards, K. L., Tominitz, M., Clarke, G. P. & Hill, A. J. (2012) Food outlet availability, deprivation and obesity in a multi-ethnic sample of pregnant women in Bradford, UK. *Social Science & Medicine*, 75 (6): 1048-1056.

Freedman, D. S., Khan, L. K., Serdula, M. K., Dietz, W. H., Srinivasan, S. R. & Berenson, G. S. (2003) Inter-relationships among childhood BMI, childhood height, and adult obesity: the Bogalusa Heart Study. *International Journal of Obesity and Related Metabolic Disorders*, 28 (1): 10-16.

Freedman, D. S., Mei, Z., Srinivasan, S. R., Berenson, G. S. & Dietz, W. H. (2007) Cardiovascular risk factors and excess adiposity among overweight children and adolescents: the Bogalusa Heart Study. *The Journal of Pediatrics*, 150 (1): 12-17.e12.

Freedman, D. S., Wang, J., Thornton, J. C., Mei, Z., Pierson, R. N., Dietz, W. H. & Horlick, M. (2008) Racial/ethnic Differences in Body Fatness Among Children and Adolescents. *Obesity*, 16 (5): 1105-1111.

Fruhstorfer, B. H., Mousoulis, C., Uthman, O. A. & Robertson, W. (2016) Socio-economic status and overweight or obesity among school-age children in sub-Saharan Africa – a systematic review. *Clinical Obesity*, 6 (1): 19-32.

Fulkerson, J. A., Neumark-Sztainer, D., Story, M., Gurvich, O., Kubik, M. Y., Garwick, A. & Dudovitz, B. (2014) The Healthy Home Offerings via the Mealtime Environment (HOME) Plus study: Design and methods. *Contemporary Clinical Trials*, 38 (1): 59-68.

Fulkerson, J. A., Story, M., Neumark-Sztainer, D. & Rydell, S. (2008) Family Meals: Perceptions of Benefits and Challenges among Parents of 8- to 10-Year-Old Children. *Journal of the American Dietetic Association*, 108 (4): 706-709.

Gale, N. K., Heath, G., Cameron, E., Rashid, S. & Redwood, S. (2013) Using the framework method for the analysis of qualitative data in multi-disciplinary health research. *BMC Medical Research Methodology*, 13 117.

Galobardes, B., Lynch, J. & Smith, G. D. (2007) Measuring socioeconomic position in health research. *British Medical Bulletin*, 81-82 (1): 21-37.

Garcia-Cervantes, L., D'Haese, S., Izquierdo-Gomez, R., Padilla-Moledo, C., Fernandez-Santos, J. R., Cardon, G. & Veiga, O. L. (2016) Physical Activity Coparticipation and Independent Mobility as Correlates of Objectively Measured Nonschool Physical Activity in Different School Grades. The UP&DOWN Study. *Journal of Physical Activity & Health*, 13 (7): 747-753.

Gatineau, M. & Mathrani, S. (2011) Ethnicity and Obesity in the UK. *Perspectives Public Health*, 131(4): 159-160.

Gehlert, S., Sohmer, D., Sacks, T., Mininger, C., McClintock, M. & Olopade, O. (2008) Targeting Health Disparities: A Model Linking Upstream Determinants To Downstream Interventions: Knowing about the interaction of societal factors and disease can enable targeted interventions to reduce health disparities. *Health Affairs (Project Hope)*, 27 (2): 339-349.

Gilbert, P. A. & Khokhar, S. (2008) Changing dietary habits of ethnic groups in Europe and implications for health. *Nutrition Reviews*, 66 (4): 203-215.

Gill, T. (2016) *Street play initiatives in disadvantaged areas: experiences and emerging issues*. London: Play England.

Gonzalez, G. & Gill, R. (2015) Exploring the relationship between prevalence of overweight and obesity in 10-11 year olds and the outdoor physical environment in North East England. PhD Thesis. Newcastle University.

Gordon-Larsen, P., Nelson, M. C. & Beam, K. (2005) Associations among active transportation, physical activity, and weight status in young adults. *Obesity Research*, 13 (5): 868-875.

Greene, J. & Thorogood, N. (2014) *Qualitative methods for health research*. 3rd edn. London: SAGE Publications Ltd.

Greene, J. C., Caracelli, V. J. & Graham, W. F. (1989) Toward a conceptual framework for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis*, 11(3): 255-274.

Greene, S. & Hogan, D. (2005) Researching Children's Experience. Exploring Children's Views through Focus Groups. In: Greene, S. & Hogan, D. eds. *Researching Children's Experience*. London: SAGE Publications: 237-253.

Greenhalgh, T., Helman, C. & Chowdhury, A. M. (1998) Health beliefs and folk models of diabetes in British Bangladeshis: a qualitative study. *BMJ*, 316 (7136): 978-983.

Griffiths, C., Frearson, A., Taylor, A., Radley, D. & Cooke, C. (2014) A cross sectional study investigating the association between exposure to food outlets and childhood obesity in Leeds, UK. *International Journal of Behavioral Nutrition and Physical Activity*, 11 (1): 138.

Griffiths, L. J., Dezateux, C. & Cole, T. J. (2011) Sex and ethnic differences in the waist circumference of 5-year-old children: findings from the Millennium Cohort Study. *International Journal of Pediatric Obesity*, 6 (2-2): e196-198.

Griffiths, L. J., Parsons, T. J. & Hill, A. J. (2010) Self-esteem and quality of life in obese children and adolescents: a systematic review. *International Journal of Pediatric Obesity*, 5 (4): 282-304.

Guetterman, T. C., Fetters, M. D. & Creswell, J. W. (2015) Integrating Quantitative and Qualitative Results in Health Science Mixed Methods Research Through Joint Displays. *Annals of Family Medicine*, 13 (6): 554-561.

Gunawardena, N., Kurotani, K., Indrawansa, S., Nonaka, D., Mizoue, T. & Samarasinghe, D. (2016) School-based intervention to enable school children to act as change agents on weight, physical activity and diet of their mothers: a cluster randomized controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, 13: 45.

Gustafson, S. L. & Rhodes, R. E. (2006) Parental Correlates of Physical Activity in Children and Early Adolescents. *Sports Medicine*, 36 (1): 79-97.

Hammersley, M. (2007) The issue of quality in qualitative research. *International Journal of Research & Method in Education*, 30 (3): 287-305.

Hancock, C. & Dinsdale, H. (2014) *NCMP Guidance for data sharing and analysis*. Oxford: Public Health England Obesity Knowledge and Intelligence.

Haroun, D., Taylor, S. J. C., Viner, R. M., Hayward, R. S., Darch, T. S., Eaton, S., Cole, T. J. & Wells, J. C. K. (2010) Validation of Bioelectrical Impedance Analysis in Adolescents Across Different Ethnic Groups. *Obesity*, 18 (6): 1252-1259.

Harrell, R. (2010) *Childhood Obesity in Coventry: A Health Needs Assessment*. Coventry: Coventry City Council.

Harrison, F., Bentham, G., Jones, A. P., Cassidy, A., van Sluijs, E. M. F. & Griffin, S. J. (2011a) School level correlates with adiposity in 9–10 year old children. *Health & Place*, 17 (3): 710-716.

Harrison, K., Bost, K. K., McBride, B. A., Donovan, S. M., Grigsby-Toussaint, D. S., Kim, J., Liechty, J. M., Wiley, A., Teran-Garcia, M. & Jacobsohn, G. C. (2011b) Toward a Developmental Conceptualization of Contributors to Overweight and Obesity in Childhood: The Six-Cs Model. *Child Development Perspectives*, 5 (1): 50-58.

Haycraft, E. L. & Blissett, J. M. (2008) Maternal and paternal controlling feeding practices: reliability and relationships with BMI. *Obesity (Silver Spring)*, 16 (7): 1552-1558.

He, F. J., Wu, Y., Feng, X. X., Ma, J., Ma, Y., Wang, H., Zhang, J., Yuan, J., Lin, C. P., Nowson, C. & MacGregor, G. A. (2015) School based education programme to reduce salt intake in children and their families (School-EduSalt): cluster randomised controlled trial. *BMJ*, 350: h770.

Health and Social Care Information Centre (2014a) *National Child Measurement Programme: England, 2013/14 school year*. [online] Available from:
http://www.hscic.gov.uk/catalogue/PUB16070/nati-chil-meas-prog-eng-2013-2014-rep.pdf (Accessed 20th July 2015).

Health and Social Care Information Centre (2014b) *National Child Measurement Programme: England, 2013/14 school year*. Leeds: Health and Social Care Information Centre.

Health and Social Care Information Centre (2015a) *National Child Measurement Programme 2015/16. IT System User Guide part 5. Progress and Data Quality Monitoring.* Leeds: Health and Social Care Information Centre.

Health and Social Care Information Centre (2015b) *National Child Measurement Programme - England, 2014-15 [NS]*. [online] Available from:
http://www.hscic.gov.uk/catalogue/PUB19109 (Accessed 18th March 2016).

Henderson, E. (2010) Adiposity in British Pakistani and White British school children aged 7-11 years living in Middlesbrough, UK: associations with ethnicity, generation, and birth weight. Doctor in Philosophy Thesis. Durham University.

Hensel, E., Rose, J., Kroese, B. S. & Banks-Smith, J. (2002) Subjective judgements of quality of life: a comparison study between people with intellectual disability and those without disability. *Journal of Intellectual Disability Research*, 46 (Pt 2): 95-107.

Hesketh, K. R., Lakshman, R. & van Sluijs, E. M. F. (2017) Barriers and facilitators to young children's physical activity and sedentary behaviour: a systematic review and synthesis of qualitative literature. *Obesity Reviews*, 18 (9): 987-1017.

Higgins, J. P. & Green, S. (2011) *Cochrane handbook for systematic reviews of interventions version 5.1.0*. John Wiley & Sons.

Higgins, V. (2008) *Ethnic Differences in Obesity, Diet and Physical Activity - A Literature review. CCSR Working Paper 2008-17*. Manchester: University of Manchester.

Higgins, V. & Dale, A. (2012) Ethnicity and childhood overweight/obesity in England. *Pediatric Obesity*, 7 (3): e22-26.

Hilbert, A. & Ried, J. (2009) Obesity in Print: An Analysis of Daily Newspapers. *Obesity Facts*, 2 (1): 46-51.

Hill, M., Laybourn, A. & Borland, M. (1996) Engaging with Primary-aged Children about their Emotions and Well-being: Methodological Considerations. *Children & Society*, 10 (2): 129-144.

Hillier-Brown, F. C., Summerbell, C. D., Moore, H. J., Routen, A., Lake, A. A., Adams, J., White, M., Araujo-Soares, V., Abraham, C., Adamson, A. J. & Brown, T. J. (2017) The impact of interventions to promote healthier ready-to-eat meals (to eat in, to take away or to be delivered) sold by specific food outlets open to the general public: a systematic review. *Obesity Reviews*, 18 (2): 227-246.

HM Government (2010) *Healthy Lives, Healthy People: Our strategy for public health in England*. Norwich: The Stationery Office.

HM Government (2016) *Childhood Obesity. A Plan for Action*. London: HM Government.

HM Revenue and Customs (2015) *Personal tax credits: Children in low-income families local measure: 2013 snapshot as at 31 August 2013*. [online] Available from: https://www.gov.uk/government/statistics/personal-tax-credits-children-in-low-income-families-local-measure-2013-snapshot-as-at-31-august-2013 (Accessed 8th November 2016).

Hornby-Turner, Y. C., Hampshire, K. R. & Pollard, T. M. (2014) A comparison of physical activity and sedentary behaviour in 9–11 year old British Pakistani and White British girls: a mixed methods study. *International Journal of Behavioral Nutrition and Physical Activity*, 11 (1): 74.

Horstman, M., Aldiss, S., Richardson, A. & Gibson, F. (2008) Methodological issues when using the draw and write technique with children aged 6 to 12 years. *Qualitative Health Research*, 18 (7): 1001-1011.

Hudda, M. T., Nightingale, C. M., Donin, A. S., Fewtrell, M. S., Haroun, D., Lum, S., Williams, J. E., Owen, C. G., Rudnicka, A. R., Wells, J. C. K., Cook, D. G. & Whincup, P. H. (2017a) Body mass index adjustments to increase the validity of body fatness assessment in UK black African and South Asian children. *International Journal of Obesity*, 41 (7): 1048-1055.

Hudda, M. T., Nightingale, C. M., Donin, A. S., Owen, C. G., Rudnicka, A. R., Wells, J. C. K., Rutter, H., Cook, D. G. & Whincup, P. H. (2017b) Patterns of childhood body mass index (BMI), overweight and obesity in South Asian and black participants in the English National child measurement programme: Effect of applying BMI adjustments standardizing for ethnic differences in BMI-body fatness associations. *International Journal of Obesity (London)*, 42(4):662-670.

Hume, C., Salmon, J. & Ball, K. (2005) Children's perceptions of their home and neighborhood environments, and their association with objectively measured physical activity: a qualitative and quantitative study. *Health Education Research*, 20 (1): 1-13.

Hunter, D. J. (2005) Choosing or losing health? *Journal of Epidemiology and Community Health*, 59 (12): 1010-1013.

Hunter, D. J., Popay, J., Tannahill, C. & Whitehead, M. (2010) Getting to grips with health inequalities at last? *BMJ*, 340: c684.

Irwin, L. G., Johnson, J. L., Henderson, A., Dahinten, V. S. & Hertzman, C. (2007) Examining how contexts shape young children's perspectives of health. *Child: Care, Health and Development*, 33 (4): 353-359.

Jabs, J., Devine, C. M., Bisogni, C. A., Farrell, T. J., Jastran, M. & Wethington, E. (2007) Trying to Find the Quickest Way: Employed Mothers' Constructions of Time for Food. *Journal of Nutrition Education and Behavior*, 39 (1): 18-25.

Jago, R., Brockman, R., Fox, K. R., Cartwright, K., Page, A. S. & Thompson, J. L. (2009) Friendship groups and physical activity: qualitative findings on how physical activity is initiated and maintained among 10-11 year old children. *International Journal of Behavioral Nutrition and Physical Activity*, 6: 4.

Jago, R., Fox, K., Page, A., Brockman, R. & Thompson, J. (2010) Parent and child physical activity and sedentary time: do active parents foster active children? *BMC Public Health*, 10: 194.

Jago, R., Sebire, S. J., Wood, L., Pool, L., Zahra, J., Thompson, J. L. & Lawlor, D. A. (2014) Associations between objectively assessed child and parental physical activity: a cross-sectional study of families with 5–6 year old children. *BMC Public Health*, 14 (1): 655.

Jayaweera, H. (2014) *Health of Migrants in the UK: What Do We Know?* University of Oxford: The Migration Observatory.

Jebb, S. A., Aveyard, P. N. & Hawkes, C. (2013) The evolution of policy and actions to tackle obesity in England. *Obesity Reviews*, 14 (S2): 42-59.

Johannsen, D. L., Johannsen, N. M. & Specker, B. L. (2006) Influence of parents' eating behaviors and child feeding practices on children's weight status. *Obesity (Silver Spring)*, 14 (3): 431-439.

Johnson, R. B., Onwuegbuzie, A. J. & Turner, L. A. (2007) Toward a Definition of Mixed Methods Research. *Journal of Mixed Methods Research*, 1 (2): 112-133.

Johnson, R. E., Grove, A. L. & Clarke, A. (2017) Pillar Integration Process: A Joint Display Technique to Integrate Data in Mixed Methods Research. *Journal of Mixed Methods Research*, 0 (0): 1558689817743108.

Joint WHO/FAO Expert Consultation (2003) *Diet, nutrition and the prevention of chronic diseases. Report of the joint WHO/FAO expert consultation. WHO Technical Report Series, No. 916 (TRS 916)*. Geneva: World Health Organization.

Karlsen, S., Morris, S., Kinra, S., Vallejo-Torres, L. & Viner, R. M. (2014) Ethnic variations in overweight and obesity among children over time: findings from analyses of the Health Surveys for England 1998–2009. *Pediatric Obesity*, 9 (3): 186-196.

Kelly, Y., Becares, L. & Nazroo, J. (2012) Associations between maternal experiences of racism and early child health and development: findings from the UK Millennium Cohort Study. *Journal of Epidemiology and Community Health*, 67 (1): 35-41.

Khambalia, A. Z., Dickinson, S., Hardy, L. L., Gill, T. & Baur, L. A. (2012) A synthesis of existing systematic reviews and meta-analyses of school-based behavioural interventions for controlling and preventing obesity. *Obesity Reviews*, 13 (3): 214-233.

Khunti, K., Stone, M. A., Bankart, J., Sinfield, P. K., Talbot, D., Farooqi, A. & Davies, M. J. (2007) Physical activity and sedentary behaviours of South Asian and white European children in inner city secondary schools in the UK. *Family Practice*, 24 (3): 237-244.

Kimbro, R. T. & Denney, J. T. (2013) Neighborhood context and racial/ethnic differences in young children's obesity: Structural barriers to interventions. *Social Science & Medicine*, 95: 97-105.

Kinge, J. M., Strand, B. H., Vollset, S. E. & Skirbekk, V. (2015) Educational inequalities in obesity and gross domestic product: evidence from 70 countries. *Journal of Epidemiology and Community Health*, 69 (12): 1141.

Kitzinger, J. (1995) Qualitative Research: Introducing focus groups. *BMJ*, 311 (7000): 299-302.

Knai, C., Petticrew, M. & Mays, N. (2016) The childhood obesity strategy. *BMJ*, 354: i4613

Knez, K., Macdonald, D. & Abbott, R. (2012) Challenging stereotypes: Muslim girls talk about physical activity, physical education and sport. *Asia-Pacific Journal of Health, Sport and Physical Education*, 3 (2): 109-122.

Koch, F. S., Sepa, A. & Ludvigsson, J. (2008) Psychological stress and obesity. *The Journal of Pediatrics*, 153 (6): 839-844.

Koshoedo, S. A., Paul-Ebhohimhen, V. A., Jepson, R. G. & Watson, M. C. (2015) Understanding the complex interplay of barriers to physical activity amongst black and minority ethnic groups in the United Kingdom: a qualitative synthesis using meta-ethnography. *BMC Public Health*, 15: 643.

Kuczmarski, R. J., Ogden, C. L., Grummer-Strawn, L. M., Flegal, K. M., Guo, S. S., Wei, R., Mei, Z., Curtin, L. R., Roche, A. F. & Johnson, C. L. (2000) CDC growth charts: United States. *Advance data*, (314): 1-27.

Kumanyika, S., Taylor, W. C., Grier, S. A., Lassiter, V., Lancaster, K. J., Morssink, C. B. & Renzaho, A. M. (2012) Community energy balance: a framework for contextualizing cultural influences on high risk of obesity in ethnic minority populations. *Preventive Medicine*, 55 (5): 371-381.

Kumanyika, S. K. (2008) Environmental influences on childhood obesity: ethnic and cultural influences in context. *Physiology & Behavior*, 94 (1): 61-70.

Kumar, B. N., Holmboe-Ottesen, G., Lien, N. & Wandel, M. (2004) Ethnic differences in body mass index and associated factors of adolescents from minorities in Oslo, Norway: a cross-sectional study. *Public Health Nutrition*, 7(8):999-1008.

Kushner, K. E. (2005) Embodied Context: Social Institutional Influences on Employed Mothers' Health Decision Making. *Health Care for Women International*, 26 (1): 69-86.

Kushner, K. E. (2007) Meaning and Action in Employed Mothers' Health Work. *Journal of Family Nursing*, 13 (1): 33-55.

Labree, L. J., van de Mheen, H., Rutten, F. F. & Foets, M. (2011) Differences in overweight and obesity among children from migrant and native origin: a systematic review of the European literature. *Obesity Reviews*, 12 (5): e535-547.

Lake, J. K., Power, C. & Cole, T. J. (1997) Child to adult body mass index in the 1958 British birth cohort: associations with parental obesity. *Archives of Disease in Childhood*, 77 (5): 376-380.

Landis, J. R. & Koch, G. G. (1977) The Measurement of Observer Agreement for Categorical Data. *Biometrics*, 33 (1): 159-174.

Landman, J. & Cruickshank, J. K. (2001) A review of ethnicity, health and nutrition-related diseases in relation to migration in the United Kingdom. *Public Health Nutrition*, 4 (2b): 647-657.

Langford, R., Bonell, C., Jones, H., Pouliou, T., Murphy, S., Waters, E., Komro, K., Gibbs, L., Magnus, D. & Campbell, R. (2015) The World Health Organization's Health Promoting Schools framework: a Cochrane systematic review and meta-analysis. *BMC Public Health*, 15: 130.

Langøien, L. J., Terragni, L., Rugseth, G., Nicolaou, M., Holdsworth, M., Stronks, K., Lien, N. & Roos, G. (2017) Systematic mapping review of the factors influencing physical activity and sedentary behaviour in ethnic minority groups in Europe: a DEDIPAC study. *International Journal of Behavioral Nutrition and Physical Activity*, 14 (1): 99.

Law, I., Hunter, S., Osler, A., Swann, S., Tzanelli, R. & Williams, F. (2008) *EDUMIGROM Working Paper 3: Ethnic relations in the UK. Ethnic Difference in Education and Diverging Prospects for Urban Youth in an Enlarged Europe.* Leeds: University of Leeds.

Lawrence, J. M., Devlin, E., Macaskill, S., Kelly, M., Chinouya, M. & Raats, M. M. (2007) Factors that affect the food choices made by girls and young women, from minority ethnic groups, living in the UK. *Journal of Human Nutrition and Dietetics*, 20 (4): 311-319.

Lawton, J., Ahmad, N., Hanna, L., Douglas, M., Bains, H. & Hallowell, N. (2008) 'We should change ourselves, but we can't': accounts of food and eating practices amongst British Pakistanis and Indians with type 2 diabetes. *Ethnicity & Health*, 13 (4): 305-319.

Lawton, J., Ahmad, N., Hanna, L., Douglas, M. & Hallowell, N. (2006) 'I can't do any serious exercise': barriers to physical activity amongst people of Pakistani and Indian origin with Type 2 diabetes. *Health Education Research*, 21 (1): 43-54.

Leary, S., Davey Smith, G. & Ness, A. (2010) No evidence of large differences in mother-daughter and father-son body mass index concordance in a large UK birth cohort. *International Journal of Obesity*, 34 (7): 1191-1192.

Leckie, G. & Charlton, C. (2013) runmlwin - A Program to Run the MLwiN Multilevel Modelling Software from within Stata. . *Journal of Statistical Software*, 52 (11): 1-40.

Leung, G. & Stanner, S. (2011) Diets of minority ethnic groups in the UK: influence on chronic disease risk and implications for prevention. *Nutrition Bulletin*, 36 (2): 161-198.

Li, B. (2013) Childhood obesity prevention in China : a mixed-methods approach to inform development of theoretically based interventions. Doctoral Thesis. University of Birmingham.

Lincoln, Y. S. & Guba, E. G. (1985) *Naturalistic inquiry.* Beverly Hills, California Sage Publications.

Liu, J., Davidson, E., Bhopal, R., White, M., Johnson, M., Netto, G., Deverill, M. & Sheikh, A. (2012) Adapting health promotion interventions to meet the needs of ethnic minority groups: mixed-methods evidence synthesis. *Health Technology Assessment*, 16 (44): 1-469.

Lloyd, A. B., Lubans, D. R., Plotnikoff, R. C., Collins, C. E. & Morgan, P. J. (2014) Maternal and paternal parenting practices and their influence on children's adiposity, screen-time, diet and physical activity. *Appetite*, 79 149-157.

Lofink, H. E. (2012) 'The worst of the Bangladeshi and the worst of the British': exploring eating patterns and practices among British Bangladeshi adolescents in east London. *Ethnicity & Health*, 17 (4): 385-401.

Long, J., Hylton, K., Spracklen, K., Ratna, A. & Bailey, S. (2009) *Systematic Review of the Literature on Black and Minority Ethnic Communities in sport and physical recreation*. Leeds: Carnegie Research Institute.

Lorenc, T., Petticrew, M., Welch, V. & Tugwell, P. (2012) What types of interventions generate inequalities? Evidence from systematic reviews. *Journal of Epidemiology and Community Health* (doi:10.1136/jech-2012-201257):

Lovasi, G. S., Hutson, M. A., Guerra, M. & Neckerman, K. M. (2009) Built environments and obesity in disadvantaged populations. *Epidemiological Reviews*, 31: 7-20.

Lucas, A., Murray, E. & Kinra, S. (2013) Heath Beliefs of UK South Asians Related to Lifestyle Diseases: A Review of Qualitative Literature. *Journal of Obesity*, 2013 13.

Luciana, S. F., Isabela, G., Fernanda, A., Adriana, P., Carolina, V. & Bruno, C. (2012) Children First Study: how an educational program in cardiovascular prevention at school can improve parents' cardiovascular risk. *European Journal of Preventive Cardiology*, 20 (2): 301-309.

Ludwig, A. F., Cox, P. & Ellahi, B. (2011) Social and cultural construction of obesity among Pakistani Muslim women in North West England. *Public Health Nutrition*, 14 (10): 1842-1850.

Madden, H. & Chamberlain, K. (2010) Nutritional health, subjectivity and resistance: Women's accounts of dietary practices. *Health*, 14 (3): 292-309.

Maher, J., Wright, J. & Tanner, C. (2013) Responsibility and resistance: women negotiating the nourishment of children. *Families, Relationships and Societies*, 2 (2): 193-209.

Malhotra, K., Herman, A. N., Wright, G., Bruton, Y., Fisher, J. O. & Whitaker, R. C. (2013) Perceived Benefits and Challenges for Low-Income Mothers of Having Family Meals with Preschool-Aged Children: Childhood Memories Matter. *Journal of the Academy of Nutrition and Dietetics*, 113 (11): 1484-1493.

Malik, V. S., Pan, A., Willett, W. C. & Hu, F. B. (2013) Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. *American Journal of Clinical Nutrition*, 98 (4): 1084-1102.

Marmot Review (2010) *Fair Society, Healthy Lives. The Marmot Review. Strategic Review of Health Inequalities in England post-2010.* London: Marmot Review.

Martinson, M. L., McLanahan, S. & Brooks-Gunn, J. (2012) Race/Ethnic and Nativity Disparities in Child Overweight in the United States and England. *Annals of the American Academy of Political and Social Science*, 643 (1): 219-238.

Martinson, M. L., McLanahan, S. & Brooks-Gunn, J. (2015) Variation in child body mass index patterns by race/ethnicity and maternal nativity status in the United States and England. *Maternal and Child Health Journal*, 19 (2): 373-380.

Mathur, R., Grundy, E. & Smeeth, L. (2013) *National Centre for Research Methods Working Paper. Availability and use of UK based ethnicity data for health research*. [online] Available from: http://eprints.ncrm.ac.uk/3040/1/Mathur-_Availability_and_use_of_UK_based_ethnicity_data_for_health_res_1.pdf (Accessed 16th June 2015).

Mavrodaris, A. (2014) *Migrant health in Coventry - Health needs assessment*. [online] Available from: http://www.coventry.gov.uk/downloads/file/17128/migrant_health_in_coventry (Accessed 19th October 2016).

Mayaba, N. N. & Wood, L. (2015) Using Drawings and Collages as Data Generation Methods With Children: Definitely Not Child's Play. *International Journal of Qualitative Methods*, 14 (5): 1609406915621407.

Maynard, M., Baker, G., Rawlins, E., Anderson, A. & Harding, S. (2009) Developing obesity prevention interventions among minority ethnic children in schools and places of worship: The DEAL (DiEt and Active Living) study. *BMC Public Health*, 9: 480.

McCarthy, J. & Edwards, R. (2011) *Key Concepts in Family Studies*. Thousand Oaks, California: SAGE Publications Ltd.

McKenzie, K. & Crowcroft, N. S. (1996) *Describing race, ethnicity, and culture in medical research*. *BMJ,* 312 (7038): 1054.

McKinley, M. C., Lowis, C., Robson, P. J., Wallace, J. M., Morrissey, M., Moran, A. & Livingstone, M. B. (2005) It's good to talk: children's views on food and nutrition. *European Journal of Clinical Nutrition*, 59 (4): 542-551.

McLaren, L. (2007) Socioeconomic Status and Obesity. *Epidemiologic Reviews*, 29 (1): 29-48.

McLennan, D., Barnes, H., Noble, M., Davies, J., Garratt, E. & Dibben, C. (2011) *The English Indices of Deprivation 2010*. London: Department for Communities and Local Government.

Mead, E., Brown, T., Rees, K., Azevedo, L. B., Whittaker, V., Jones, D., Olajide, J., Mainardi, G. M., Corpeleijn, E., O'Malley, C., Beardsmore, E., Al-Khudairy, L., Baur, L., Metzendorf, M. I., Demaio, A. & Ells, L. J. (2017) Diet, physical activity and behavioural interventions for the treatment of overweight or obese children from the age of 6 to 11 years. *Cochrane Database of Systematic Reviews*, 6: Cd012651.

Michie, S., Atkins, L. & West, R. (2014) *The Behaviour Change Wheel. A Guide to Designing Interventions*. Great Britain: Silverback Publishing.

Miles, C. & Benn, T. (2016) A case study on the experiences of university-based Muslim women in physical activity during their studies at one UK higher education institution. *Sport, Education and Society*, 21 (5): 723-740.

Mills, S., White, M., Brown, H., Wrieden, W., Kwasnicka, D., Halligan, J., Robalino, S. & Adams, J. (2017) Health and social determinants and outcomes of home cooking: A systematic review of observational studies. *Appetite*, 111: 116-134.

Mir, G., Salway, S., Kai, J., Karlsen, S., Bhopal, R., Ellison, G. T. H. & Sheikh, A. (2013) Principles for research on ethnicity and health: the Leeds Consensus Statement. *European Journal of Public Health*, 23 (3): 504-510.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G. & The, P. G. (2009) Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Medicine*, 6 (7): e1000097.

Monteiro, C. A., Moura, E. C., Conde, W. L. & Popkin, B. M. (2004) Socioeconomic status and obesity in adult populations of developing countries: a review. *Bulletin of the World Health Organization*, 82 (12): 940-946.

Monteiro, P. O. A. & Victora, C. G. (2005) Rapid growth in infancy and childhood and obesity in later life – a systematic review. *Obesity Reviews*, 6 (2): 143-154.

Moreno, L. A. & Rodriguez, G. (2007) Dietary risk factors for development of childhood obesity. *Current Opinion in Clinical Nutrition & Metabolic Care*, 10 (3): 336-341.

MRC Biostatistics Unit (2017) *DIC: Deviance Information Criteria*. [online] Available from: http://www.mrc-bsu.cam.ac.uk/software/bugs/the-bugs-project-dic/#Top (Accessed 17th April 2017).

Mu'Min Chowdhury, A., Helman, C. & Greenhalgh, T. (2000) Food beliefs and practices among British Bangladeshis with diabetes: Implications for health education. *Anthropology & Medicine*, 7 (2): 209-226.

Murphy, M., Robertson, W. & Oyebode, O. (2017) Obesity in International Migrant Populations. *Current Obesity Reports*, 6 (3): 314-323.

Must, A. & Anderson, S. E. (2006) Body mass index in children and adolescents: considerations for population-based applications. *International Journal of Obesity*, 30 (4): 590-594.

Mvo, Z. (1999) Perceptions of overweight African women about acceptable body size of women and children. *Curationis*, 22 (2): 5.

Myers, H. F. (2009) Ethnicity- and socio-economic status-related stresses in context: an integrative review and conceptual model. *Journal of Behavioral Medicine*, 32 (1): 9-19.

Narang, I. & Mathew, J. L. (2012) Childhood obesity and obstructive sleep apnea. *Journal of Nutrition & Metabolism*, 2012: 134202.

Nastasi, B. K. & Hitchcock, J. H. (2016) *Mixed methods research and culture-specific interventions. Program design and evaluation*. Thousand Oaks, California: SAGE Publications, Inc.

Nastasi, B. K., Schensul, J. J., Schensul, S. L., Mekki-Berrada, A., Pelto, P. J., Maitra, S., Verma, R. & Saggurti, N. (2015) A Model for Translating Ethnography and Theory into Culturally Constructed Clinical Practices. *Culture, medicine and psychiatry*, 39 (1): 92-120.

National Children's Bureau (2015) *Involving Children and Young People in Policy, Practice and Research*. London: NCB.

National Institute for Health (2016) *Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies*. [online] Available from: http://www.nhlbi.nih.gov/health-pro/guidelines/in-develop/cardiovascular-risk-reduction/tools/cohort (Accessed 1st November 2016).

National Institute for Health and Clinical Excellence (2007) *Behaviour Change at Population, Community and Individual Levels. NICE Public Health Guidance*. London: NICE.

National Institute for Health and Care Excellence (2013) *BMI: preventing ill health and premature death in black, Asian and other minority ethnic groups. Public health guideline [PH46]*. London: NICE.

National Institute for Health and Care Excellence (2014a) *Obesity: identification, assessment and management of overweight and obesity in children, young people and adults. NICE clinical guideline 189.* London: NICE.

National Institute for Health and Clinical Excellence (2014b) *Body mass index thresholds for intervening to prevent ill health among black, Asian and other minority ethnic groups. NICE local government briefings 13.* London: NICE.

National Obesity Observatory (2009) *Body Mass Index as a measure of obesity.* [online] Available from: http://www.noo.org.uk/uploads/doc789_40_noo_BMI.pdf (Accessed 8th June 2015).

National Statistics (2008) *Guidance notes for the 2001 Area Classification of Super Output Areas and Data Zones February 2008* England: Office for National Statistics.

National Statistics (2016) *Schools, pupils and their characteristics: January 2016*. [online] Available from: https://www.gov.uk/government/statistics/schools-pupils-and-their-characteristics-january-2016 (Accessed 8th November 2016).

Nazroo, J. Y. (1998) Genetic, Cultural or Socio-economic Vulnerability? Explaining Ethnic Inequalities in Health. *Sociology of Health & Illness*, 20 (5): 710-730.

Nazroo, J. Y. (2001) *Ethnic Inequalities in Health*. Chichester, UK.: John Wiley & Sons, Ltd.

Nazroo, J. Y. (2003) The Structuring of Ethnic Inequalities in Health: Economic Position, Racial Discrimination, and Racism. *American Journal of Public Health*, 93 (2): 277-284.

Nazroo, J. Y., Williams, D. R., Marmot, M. & Wilkinson, R. G. (2006) The Social Determination of Ethnic/Racial Inequalities in Health. In: eds. *Social Determinants of Health*. 2nd edn. Oxford: Oxford University Press.

Neumark-Sztainer, D. (2005) Preventing the broad spectrum of weight-related problems: working with parents to help teens achieve a healthy weight and a positive body image. *Journal of Nutrition Education and Behavior*, 37 Suppl 2: S133-140.

Nickelson, J., Bryant, C. A., McDermott, R. J., Buhi, E. R. & DeBate, R. D. (2012) A Modified Obesity Proneness Model Predicts Adolescent Weight Concerns and Inability to Self-Regulate Eating. *Journal of School Health*, 82 (12): 560-571.

Nicolaou, M., Benjelloun, S., Stronks, K., Dam, R., Seidell, J. & Doak, C. (2012) Influences on body weight of female Moroccan migrants in the Netherlands: a qualitative study. *Health & Place*, 18 (4):883-91.

Nicolaou, M., Doak, C. M., Dam, R. M., Brug, J., Stronks, K. & Seidell, J. C. (2009) Cultural and social influences on food consumption in Dutch residents of Turkish and Moroccan origin: a qualitative study. *Journal of Nutrition Education and Behavior*, 41 (4):232-41.

Nightingale, C. M., Rudnicka, A. R., Owen, C. G., Wells, J. C. K., Sattar, N., Cook, D. G. & Whincup, P. H. (2013) Influence of Adiposity on Insulin Resistance and Glycemia Markers Among U.K. Children of South Asian, Black African-Caribbean, and White European Origin. *Child Heart and Health Study in England*, 36 (6): 1712-1719.

Noonan, R. J., Boddy, L. M., Fairclough, S. J. & Knowles, Z. R. (2016a) Write, draw, show, and tell: a child-centred dual methodology to explore perceptions of out-of-school physical activity. *BMC Public Health*, 16 326.

Noonan, R. J., Boddy, L. M., Knowles, Z. R. & Fairclough, S. J. (2016b) Cross-sectional associations between high-deprivation home and neighbourhood environments, and health-related variables among Liverpool children. *BMJ Open*, 6 (1): e008693.

Nordahl, H., Krølner, R., Páll, G., Currie, C. & Andersen, A. (2011) Measurement of Ethnic Background in Cross-national School Surveys: Agreement Between Students' and Parents' Responses. *Journal of Adolescent Health*, 49 (3): 272-277.

O'Cathain, A., Murphy, E. & Nicholl, J. (2007) Integration and Publications as Indicators of "Yield" From Mixed Methods Studies. *Journal of Mixed Methods Research*, 1 (2): 147-163.

O'Cathain, A. & Thomas, K. (2006) Combining qualitative and quantitative methods. In: Pope, C. & Mays, N. eds. *Qualitative Research in Health Care*. Oxford: Blackwell Publishing.

O'Cathain, A., Murphy, E. & Nicholl, J. (2010) Three techniques for integrating data in mixed methods studies. *BMJ*, 341: c4587.

O'Reilly, M. & Kiyimba, N. (2015) *Advanced qualitative research. A guide to using theory.* London: SAGE.

Ochieng, B. M. N. (2010) "You Know What I Mean": The Ethical and Methodological Dilemma and Challenges for Black Researchers Interviewing Black Families. *Qualitative Health Research*, 20 (12): 1725-1735.

Ochieng, B. M. N. (2013) Black families' perceptions of barriers to the practice of a healthy lifestyle: a qualitative study in the UK. *Critical Public Health*, 23 (1): 6-16.

Office for National Statistics (2012) *Ethnicity and National Identity in England and Wales 2011*. [online] Available from: http://www.ons.gov.uk/ons/dcp171776_290558.pdf (Accessed 16th June 2015).

Office for National Statistics (2015) *2011 Census, Key Statistics for Local Authorities in England and Wales*. [online] Available from: http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-286262 (Accessed 4th August 2015).

Office for National Statistics (2016a) *Regional gross disposable household income (GDHI): 1997 to 2014*. [online] Available from: http://www.ons.gov.uk/economy/regionalaccounts/grossdisposablehouseholdincome/bulletins/regionalgrossdisposablehouseholdincomegdhi/2014#local-area-nuts3-gdhi-estimates (Accessed 8th November 2016).

Office for National Statistics (2016b) *Population Estimates for UK, England and Wales, Scotland and Northern Ireland*. [online] Available from: http://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatesforukenglandandwalesscotlandandnorthernireland (Accessed 8th November 2016).

Office for National Statistics (2016c) *Explore 50 years of international migration to and from the UK*. [online] Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/internationalmigration/articles/explore50yearsofinternationalmigrationtoandfromtheuk/2016-12-01 (Accessed 24th April 2018).

Ofsted (2016) *Find an inspection report*. [online] Available from: http://reports.ofsted.gov.uk/ (Accessed 21st March 2016).

Olds, T., Thomas, S., Lewis, S. & Petkov, J. (2013) Clustering of attitudes towards obesity: a mixed methods study of Australian parents and children. *International Journal of Behavioral Nutrition and Physical Activity*, 10 (1): 117.

Oliver, S., Kavanagh, J., Caird, J., Lorenc, T., Oliver, K., Harden, A., Thomas, J., Greaves, A. & Oakley, A. (2008) *Health promotion, inequalities and young people's health: a systematic review of research. Technical Report*. London: EPPI-Centre.

Onwuegbuzie, A. J. (2012) Introduction. Putting the MIXED back into quantitative and qualitative research in educational research and beyond: Moving toward the radical middle. *International Journal of Multiple Research Approaches*, 6 (3): 192-219.

Osei-Kwasi, H. A., Nicolaou, M., Powell, K., Terragni, L., Maes, L., Stronks, K., Lien, N. & Holdsworth, M. (2016) Systematic mapping review of the factors influencing dietary behaviour in ethnic minority groups living in Europe: a DEDIPAC study. *International Journal of Behavioral Nutrition and Physical Activity*, 13 (1): 85.

Osei-Kwasi, H. A., Powell, K., Nicolaou, M. & Holdsworth, M. (2017) The influence of migration on dietary practices of Ghanaians living in the United Kingdom: a qualitative study. *Annals of Human Biology*, 44 (5): 454-463.

Oude Luttikhuis, H., Baur, L., Jansen, H., Shrewsbury, V. A., O'Malley, C., Stolk, R. P. & Summerbell, C. D. (2009) Interventions for treating obesity in children. *Cochrane Database of Systematic Reviews*, (1): CD001872.

Owen, C. G., Nightingale, C. M., Rudnicka, A. R., Sattar, N., Cook, D. G., Ekelund, U. & Whincup, P. H. (2010) Physical activity, obesity and cardiometabolic risk factors in 9- to 10-year-old UK children of white European, South Asian and black African-Caribbean origin: the Child Heart And health Study in England (CHASE). *Diabetologia*, 53 (8): 1620-1630.

Pallan, M., Griffin, T., Lancashire, E., Hurley, K., Blissett, J., Frew, E., Gill, P., Griffith, L., Hemming, K., Jolly, K., McGee, E., Mulhern, C., Parry, J., Thompson, J. L. & Adab, P. (2016) Cultural adaptation of a children's weight management programme for Bangladeshi and Pakistani families in the UK: a cluster-randomised feasibility study protocol. *Pilot and Feasibility Studies*, 2 (1): 48.

Pallan, M., Parry, J. & Adab, P. (2012) Contextual influences on the development of obesity in children: a case study of UK South Asian communities. *Preventive Medicine*, 54 (3-4): 205-211.

Pallan, M., Parry, J., Cheng, K. K. & Adab, P. (2013) Development of a childhood obesity prevention programme with a focus on UK South Asian communities. *Preventive Medicine*, 57 (6): 948-954.

Pallan, M. J., Adab, P., Sitch, A. J. & Aveyard, P. (2014) Are school physical activity characteristics associated with weight status in primary school children? A multilevel cross-sectional analysis of routine surveillance data. *Archives of Disease in Childhood*, 99 (2): 135-141.

Pallan, M. J., Hiam, L. C., Duda, J. L. & Adab, P. (2011) Body image, body dissatisfaction and weight status in south asian children: a cross-sectional study. *BMC Public Health*, 11 (1): 21.

Pantoja, A., Perry, W. & Blourock, B. (1976) Towards the Development of Theory: Cultural Pluralism Redefined. *The Journal of Sociology & Social Welfare*, 4 (1): Article 11.

Paradies, Y., Ben, J., Denson, N., Elias, A., Priest, N., Pieterse, A., Gupta, A., Kelaher, M. & Gee, G. (2015) Racism as a Determinant of Health: A Systematic Review and Meta-Analysis. *PLoS One*, 10 (9): e0138511.

Park, M. H., Falconer, C. L., Croker, H., Saxena, S., Kessel, A. S., Viner, R. M. & Kinra, S. (2014) Predictors of health-related behaviour change in parents of overweight children in England. *Preventive Medicine*, 62: 20-4.

Parks, E. P., Kazak, A., Kumanyika, S., Lewis, L. & Barg, F. K. (2016) Perspectives on Stress, Parenting, and Children's Obesity-Related Behaviors in Black Families. *Health education & behavior: the official publication of the Society for Public Health Education*, 43 (6): 632-640.

Parks, E. P., Kumanyika, S., Moore, R. H., Stettler, N., Wrotniak, B. H. & Kazak, A. (2012) Influence of Stress in Parents on Child Obesity and Related Behaviors. *Pediatrics*, 130 (5): e1096-e1104.

Parliamentary Office of Science and Technology (2007) *Postnote January 2007 Number 276 Ethnicity and health* London: POST.

Parsons, T. J., Power, C., Logan, S. & Summerbell, C. D. (1999) Childhood predictors of adult obesity: a systematic review. *International Journal of Obesity and Related Metabolic Disorders*, 23 Suppl 8: S1-107.

Patton, M. Q. (1990) *Qualitative evaluation and research methods*. 2nd edn. Thousand Oaks, CA: Sage Publications, Inc.

Paulis, W. D., Silva, S., Koes, B. W. & van Middelkoop, M. (2014) Overweight and obesity are associated with musculoskeletal complaints as early as childhood: a systematic review. *Obesity Reviews*, 15 (1): 52-67.

Pearce, A., Kirk, C., Cummins, S., Collins, M., Elliman, D., Connolly, A. M. & Law, C. (2009) Gaining children's perspectives: a multiple method approach to explore environmental influences on healthy eating and physical activity. *Health & Place*, 15 (2): 614-621.

Perez-Pastor, E. M., Metcalf, B. S., Hosking, J., Jeffery, A. N., Voss, L. D. & Wilkin, T. J. (2009) Assortative weight gain in mother-daughter and father-son pairs: an emerging source of childhood obesity. Longitudinal study of trios (EarlyBird 43). *International Journal of Obesity*, 33 (7): 727-735.

Persson, G., Mahmud, A. J., Hansson, E. E. & Strandberg, E. L. (2014) Somali women's view of physical activity – a focus group study. *BMC Women's Health*, 14 (1): 129.

Piko, B. F. & Bak, J. (2006) Children's perceptions of health and illness: images and lay concepts in preadolescence. *Health Education Research*, 21 (5): 643-653.

Play England (2016) *Why temporary street closures for play make sense for public health*. London: Play England.

Pocock, M., Trivedi, D., Wills, W., Bunn, F. & Magnusson, J. (2010) Parental perceptions regarding healthy behaviours for preventing overweight and obesity in young children: a systematic review of qualitative studies. *Obesity Reviews*, 11 (5): 338-353.

Popay, J., Roberts, H., Sowden, A., Petticrew, M., Arai, L., Rodgers, M., Britten, N., Roen, K. & Duffy, S. (2006) *Guidance on the Conduct of Narrative Synthesis in Systematic Reviews. A Product from the ESRC Methods Programme* [online] Available from: https://www.researchgate.net/profile/Lisa_Arai/publication/242311393_Guidance_on_the_conduct_of_narrative_synthesis_in_systematic_reviews_a_comparison_of_guidance-led_narrative_synthesis_versus_meta-analysis/links/5532159f0cf2f2a588ad67fd.pdf (Accessed 10th February 2017).

Pope, C. & Mays, N. (2006) *Qualitative research in health care*. Third edn. Oxford: Blackwell Publishing Ltd.

Popkin, B. M., Adair, L. S. & Ng, S. W. (2012) Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition Reviews*, 70 (1): 3-21.

Power, C., Lake, J. K. & Cole, T. J. (1997) Body mass index and height from childhood to adulthood in the 1958 British born cohort. *The American Journal of Clinical Nutrition*, 66 (5): 1094-1101.

Preston, E. (2014) Prevalence, perceptions and potential interventions : a mixed methods investigation of childhood overweight and obesity among a pro-poor cohort in Peru. Doctoral Thesis. University of Oxford.

Priest, N., Paradies, Y., Trenerry, B., Truong, M., Karlsen, S. & Kelly, Y. (2013) A systematic review of studies examining the relationship between reported racism and health and wellbeing for children and young people. *Social Science & Medicine*, 95: 115-127.

Public Health England (2014) *Coventry Unitary Authority Health Profile 2014*. [online] Available from:
http://www.coventry.gov.uk/downloads/download/3694/coventry_health_profiles (Accessed 23rd June 2015).

Public Health England (2015) *National Child Measurement Programme Operational Guidance 2015 to 2016*. London: Public Health England.

Public Health England (2016) *National Child Measurement Programme. Changes in children's body mass index between 2006/7 and 2014/15*. London: Public Health England.

Public Health England (2017a) *Health matters: obesity and the food environment*. [online] Available from:
https://www.gov.uk/government/publications/health-matters-obesity-and-the-food-environment/health-matters-obesity-and-the-food-environment--2 (Accessed 31st January 2018).

Public Health England (2017b) *Public Health Outcomes Framework: Health Equity Report. Focus on ethnicity*. London: PHE publications.

Puoane, T., Fourie, J. M., Shapiro, M., Rosling, L., Tshaka, N. C. & Oelefse, A. (2005) 'Big is beautiful'; - an exploration with urban black community health workers in a South African township. *South African Journal of Clinical Nutrition*, 18 (1): 6-15.

Quintana, S. M. (1999) Children's developmental understanding of ethnicity and race. *Applied and Preventive Psychology*, 7 (1): 27-45.

Rasbash, J., Charlton, C., Browne, W. J., Healy, M. & Cameron, B. (2009) *MLwiN Version 2.10.* University of Bristol: Centre for Multilevel Modelling.

Rasbash, J., Steele, F., Browne, W. J. & Goldstein, H. (2016) *A User's Guide to MLwiN, v2.36*. University of Bristol: Centre for Multilevel Modelling.

Rawlins, E., Baker, G., Maynard, M. & Harding, S. (2013) Perceptions of healthy eating and physical activity in an ethnically diverse sample of young children and their parents: the DEAL prevention of obesity study. *Journal of Human Nutrition and Dietetics*, 26 (2):132-44.

Rees, R., Oliver, K., Woodman, J. & Thomas, J. (2011) The views of young children in the UK about obesity, body size, shape and weight: a systematic review. *BMC Public Health*, 11: 188.

Reilly, J. J. (2002) Assessment of Childhood Obesity: National Reference Data or International Approach? *Obesity Research*, 10 (8): 838-840.

Reilly, J. J., Armstrong, J., Dorosty, A. R., Emmett, P. M., Ness, A., Rogers, I., Steer, C. & Sherriff, A. (2005) Early life risk factors for obesity in childhood: cohort study. *BMJ*, 330 (7504): 1357.

Reilly, J. J., Methven, E., McDowell, Z. C., Hacking, B., Alexander, D., Stewart, L. & Kelnar, C. J. H. (2003) Health consequences of obesity. *Archives of Disease in Childhood*, 88 (9): 748-752.

Rguibi, M. & Belahsen, R. (2006) Body size preferences and sociocultural influences on attitudes towards obesity among Moroccan Sahraoui women. *Body Image*, 3 (4): 395-400.

Rhodes, P. J. (1994) Race-of-Interviewer Effects: A Brief Comment. *Sociology*, 28 (2): 547-558.

Ridler, C., Dinsdale, H. & Rutter, H. (2013) *National Child Measurement Programme: Changes in children's body mass index between 2006/07 and 2011/12*. Oxford: National Obesity Observatory.

Ridler, C., Townsend, N., Dinsdale, H., Mulhall, C. & Rutter, H. (2009) *National Child Measurement Programme: Detailed Analysis of the 2007/08 National Dataset*. Oxford: National Obesity Observatory.

Robertson, W., Fleming, J., Kamal, A., Hamborg, T., Khan, K. A., Griffiths, F., Stewart-Brown, S., Stallard, N., Petrou, S., Simkiss, D., Harrison, E., Kim, S. W. & Thorogood, M. (2017) Randomised controlled trial and economic evaluation of the 'Families for Health' programme to reduce obesity in children. *Archives of Disease in Childhood*, 102 (5): 416-426.

Robertson, W., Murphy, M. & Johnson, R. (2016) Evidence base for the prevention and management of child obesity. *Paediatrics and Child Health*, 26 (5): 212-218.

Robinson, S., Yardy, K. & Carter, V. (2012) A narrative literature review of the development of obesity in infancy and childhood. *Journal of Child Health Care*, 16 (4): 339-354.

Rogers, C., Anderson, S. E., Dollahite, J. S., Hill, T. F., Holloman, C., Miller, C. K., Pratt, K. J. & Gunther, C. (2017) Methods and design of a 10-week multi-component family meals intervention: a two group quasi-experimental effectiveness trial. *BMC Public Health*, 17 (1): 50.

Rona, R. J. & Chinn, S. (1987) National Study of Health and Growth: social and biological factors associated with weight-for-height and triceps skinfold of children from ethnic groups in England. *Annals of Human Biology*, 14 (3): 231-248.

Ruan, H., Xun, P., Cai, W., He, K. & Tang, Q. (2015) Habitual Sleep Duration and Risk of Childhood Obesity: Systematic Review and Dose-response Meta-analysis of Prospective Cohort Studies. *Scientific Reports*, 5: 16160.

Russell, A., Aloa, V., Feder, T., Glover, A., Miller, H. & Palmer, G. (1998) Sex-Based Differences in Parenting Styles in a Sample with Preschool Children. *Australian Journal of Psychology*, 50 (2): 89-99.

Sallis, F., Owen, N. & Fisher, E. B. (2008) Ecological models of health behaviour. In: Glanz, K., Rimer, R. K. & Viswanath, K. eds. *Health behavior and health education: theory, research and practice.* 4th edn. San Francisco: Jossey-Bass Inc.: 465 - 485.

Salvy, S.-J., Bowker, J. W., Roemmich, J. N., Romero, N., Kieffer, E., Paluch, R. & Epstein, L. H. (2008) Peer Influence on Children's Physical Activity: An Experience Sampling Study. *Journal of Pediatric Psychology*, 33 (1): 39-49.

Salway, S., Mir, G., Turner, D., Ellison, G. T. H., Carter, L. & Gerrish, K. (2016) Obstacles to “race equality” in the English National Health Service: Insights from the healthcare commissioning arena. *Social Science & Medicine*, 152: 102-110.

Salway, S. M., Nazroo, J., Mir, G., Craig, G., Johnson, M. & Gerrish, K. (2010) *Fair Society, Healthy Lives: a missed opportunity to address ethnic inequalities in health*. [online] Available from: https://www.bmj.com/rapid-response/2011/11/02/fair-society-healthy-lives-missed-opportunity-address-ethnic-inequalities- (Accessed 25th April 2018).

Sampilo, M. L. (2014) Enhancing Interventions for Pediatric Obesity Among Young Latino Children: A Mixed Methods Study. Doctor of Philosophy Thesis. University of Kansas.

Sandhu, K., Stephenson, M. & Harrison, J. (2013) *Layers of Inequality. A Human Rights and Equality Impact Assessment of the Spending Cuts on Black, Asian and Minority Ethnic women in Coventry*. Coventry: A Joint Report of Coventry Women’s Voices, C.E.M.A.P., Foleshill Women’s Training and the Centre for Human Rights in Practice, School of Law, University of Warwick.

Sanghera, G. S. & Thapar-Björkert, S. (2008) Methodological dilemmas: gatekeepers and positionality in Bradford. *Ethnic and Racial Studies*, 31 (3): 543-562.

Satia-Abouta, J. (2003) Dietary Acculturation : Definition, Process, Assessment, and Implications. *International Journal of Human Ecology*, 4: 71-86.

Satia-Abouta, J. (2010) Dietary acculturation and the nutrition transition: an overview. *Applied Physiology, Nutrition, and Metabolism*, 35 (2): 219-223.

Sawyer, A., Ucci, M., Jones, R., Smith, L. & Fisher, A. (2018) Supportive environments for physical activity in deprived communities in the United Kingdom: A qualitative study using photo elicitation. *Social Science & Medicine*, 197: 49-58.

Schierup, C., Hansen, P. & Castles, S. (2006) *Migration, Citizenship, and the European Welfare State: A European Dilemma*. Oxford: Oxford University Press.

Schwandt, T. A. (1997) *Qualitative inquiry: A dictionary of terms*. Sage Publications, Inc.

Schwartz, M. B., Chambliss, H. O. N., Brownell, K. D., Blair, S. N. & Billington, C. (2003) Weight Bias among Health Professionals Specializing in Obesity. *Obesity Research*, 11 (9): 1033-1039.

Scientific Advisory Committee on Nutrition and the Royal College of Paediatrics and Child Health (2012) *Consideration of issues around the use of BMI centile thresholds for defining underweight, overweight and obesity in children aged 2-18 years in the UK* [online] Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/339411/SACN_RCPCH_defining_child_underweight__overweight_and_obesity_in_the_UK_2012.pdf (Accessed 9th May 2018).

Scott, P. (2001) Caribbean people's health beliefs about the body and their implications for diabetes management: a South London study. *Practical Diabetes International*, 18 (3): 94-98.

Senior, P. A. & Bhopal, R. (1994) Ethnicity as a variable in epidemiological research. *BMJ*, 309 (6950): 327-330.

Shaltout, M. (2014) Investigating home environment influences on obesity in urban Egyptian children aged 2-12. Doctoral Thesis. University of Salford.

Shaw, N. J., Crabtree, N. J., Kibirige, M. S. & Fordham, J. N. (2007) Ethnic and gender differences in body fat in British schoolchildren as measured by DXA. *Archives of Disease in Childhood*, 92 (10): 872-875.

Silventoinen, K., Rokholm, B., Kaprio, J. & Sorensen, T. I. A. (2009) The genetic and environmental influences on childhood obesity: a systematic review of twin and adoption studies. *International Journal of Obesity*, 34 (1): 29-40.

Silverman, D. (2014) *Interpreting qualitative data*. 5 edn. London: SAGE.

Smith, N. (2010) Intergenerational Continuities in Ethnic Inequalities in Health in the UK. Doctor of Philosophy Thesis. University College London.

Smith, N. R., Kelly, Y. J. & Nazroo, J. Y. (2009) Intergenerational continuities of ethnic inequalities in general health in England. *Journal of Epidemiology and Community Health*, 63 (3): 253-258.

Smith, N. R., Kelly, Y. J. & Nazroo, J. Y. (2012) The effects of acculturation on obesity rates in ethnic minorities in England: evidence from the Health Survey for England. *European Journal of Public Health*, 22 (4): 508-513.

Solomon-Moore, E., Toumpakari, Z., Sebire, S. J., Thompson, J. L., Lawlor, D. A. & Jago, R. (2018) Roles of mothers and fathers in supporting child physical activity: a cross-sectional mixed-methods study. *BMJ Open*, 8 (1):

Sproston, K. & Mindell, J. (2006) *Health Survey for England 2004. The health of minority ethnic groups*. Leeds: The Information Centre.

Stankov, I., Olds, T. & Cargo, M. (2012) Overweight and obese adolescents: what turns them off physical activity? *International Journal of Behavioral Nutrition and Physical Activity*, 9: 53.

Stride, A. (2014) Let US tell YOU! South Asian, Muslim girls tell tales about physical education. *Physical Education and Sport Pedagogy*, 19 (4): 398-417.

Stride, A. (2016) Centralising space: the physical education and physical activity experiences of South Asian, Muslim girls. *Sport, Education and Society*, 21 (5): 677-697.

Syrad, H., Falconer, C., Cooke, L., Saxena, S., Kessel, A. S., Viner, R., Kinra, S., Wardle, J. & Croker, H. (2014) "Health and happiness is more important than weight": a qualitative investigation of theviews of parents receiving written feedback on their child's weight as part of the National Child Measurement Programme. *Journal of Human Nutrition and Dietetics*, 28(1):47-55.

Szajewska, H. & Ruszczynski, M. (2010) Systematic review demonstrating that breakfast consumption influences body weight outcomes in children and adolescents in Europe. *Critical Reviews in Food Science and Nutrition*, 50 (2): 113-119.

Tabacchi, G., Giammanco, S., La Guardia, M. & Giammanco, M. (2007) A review of the literature and a new classification of the early determinants of childhood obesity: from pregnancy to the first years of life. *Nutrition Research*, 27 (10): 587-604.

Tanner, C., Maher, J. & Fraser, S. (2013) 'I don't want her to be overweight like i was as a girl'. *Australian Feminist Studies*, 28 (76): 177-194.

Taylor, R. W., Grant, A. M., Goulding, A. & Williams, S. M. (2005) Early adiposity rebound: review of papers linking this to subsequent obesity in children and adults. *Current Opinion in Clinical Nutrition and Metabolic Care*, 8 (6): 607-612.

Te Morenga, L., Mallard, S. & Mann, J. (2013) Dietary sugars and body weight: systematic review and meta-analyses of randomised controlled trials and cohort studies. *BMJ*, 346: e7492

Teddlie, C. & Tashakkori, A. (2003) Major issues and controversies in the use of mixed methods in the social and behavioural sciences. In: Tashakkori, A. & Teddlie, C. eds. *Handbook of mixed methods in social and behavioural research*. London: Sage Publications:

The National Archives (2018) *Citizenship. Brave new world: Post-war immigration*. [online] Available from: http://www.nationalarchives.gov.uk/pathways/citizenship/brave_new_world/immigration.htm (Accessed 24th April 2018).

Thomas, C., Nightingale, C. M., Donin, A. S., Rudnicka, A. R., Owen, C. G., Sattar, N., Cook, D. G. & Whincup, P. H. (2012) Socio-economic position and type 2 diabetes risk factors: patterns in UK children of South Asian, black African-Caribbean and white European origin. *PLoS One*, 7 (3): e32619.

Thomas, J., Sutcliffe, K., Harden, A., Oakley, A., Oliver, S., Rees, R., Brunton, G. & Kavanagh, J. (2003) *Children and healthy eating: a systematic review of barriers and facilitators.* London: University of London, I.o.E., Social Science Research Unit, EPPI-Centre.

Thompson, J. L., Jago, R., Brockman, R., Cartwright, K., Page, A. S. & Fox, K. R. (2010) Physically active families – de-bunking the myth? A qualitative study of family participation in physical activity. *Child: Care, Health and Development*, 36 (2): 265-274.

Throsby, K. & Evans, B. (2013) 'Must I seize every opportunity?' Complicity, confrontation and the problem of researching (anti-) fatness. *Critical Public Health*, 23 (3): 331-344.

Toselli, S., Rinaldo, N. & Gualdi-Russo, E. (2016) Body image perception of African immigrants in Europe. *Globalization and Health*, 12 (1): 48.

Tovar, A., Renzaho, A. M. N., Guerrero, A. D., Mena, N. & Ayala, G. X. (2014) A Systematic Review of Obesity Prevention Intervention Studies among Immigrant Populations in the US. *Current Obesity Reports*, 3 (2): 206-222.

Tovée, M. J., Swami, V., Furnham, A. & Mangalparsad, R. (2006) Changing perceptions of attractiveness as observers are exposed to a different culture. *Evolution and Human Behavior*, 27 (6): 443-456.

Towey, M., Harrell, R. & Lee, B. (2011) Evaluation of "One Body, One Life": A Community-Based Family Intervention for the Prevention of Obesity in Children. *Journal of Obesity*, 2011 7.

Towns, N. & D'Auria, J. (2009) Parental Perceptions of Their Child's Overweight: An Integrative Review of the Literature. *Journal of Pediatric Nursing*, 24 (2): 115-130.

Townsend, N. & Ridler, C. (2009) *Health inequalities and childhood obesity: are ethnicity and the urban environment determinants of obesity or is deprivation a confounding factor for both?* IN: 17th European Congress on Obesity. Amsterdam. Available from: https://khub.net/c/document_library/get_file?uuid=3dc46a45-c61e-4f9e-8047-c948a226c263&groupId=31798783 (Accessed 16th August 2017).

Townsend, N., Rutter, H. & Foster, C. (2012) Age differences in the association of childhood obesity with area-level and school-level deprivation: cross-classified multilevel analysis of cross-sectional data. *International Journal of Obesity (London)*, 36 (1): 45-52.

Tracy, S. (2010) Qualitative Quality: Eight "Big-Tent" Criteria for Excellent Qualitative Research. *Qualitative Inquiry*, 16 (10): 837-851.

Trigwell, J. (2011) Addressing childhood obesity in ethnic minority populations. Doctor of Philosophy Thesis. Liverpool John Moores University.

Trigwell, J., Murphy, R. C., Cable, N. T., Stratton, G. & Watson, P. M. (2015) Parental views of children's physical activity: a qualitative study with parents from multi-ethnic backgrounds living in England. *BMC Public Health*, 15 (1): 1005.

Trigwell, J., Watson, P., Murphy, R., Stratton, G. & Cable, N. (2014) Ethnic differences in parental attitudes and beliefs about being overweight in childhood. *Health Education Journal*, 73 (2): 179-191.

United Nations (1989) *The United Nations Convention on the Rights of the Child*. London: UNICEF UK.

United Nations Development Programme (2015) *Human Development Report 2015 Statistical annex*. Washington DC: Communications Development Incorporated.

Universities of Leeds and Glamorgan and the London School of Hygiene and Tropical Medicine (1998) *The Health of the Nation - a policy assessed*. London: The Stationery Office.

Uskul, A. K. & Platt, L. (2014) *A note on maintenance of ethnic origin diet and healthy eating in understanding society. ISER Working Paper Series, No. 2014-03*. University of Essex: Institute for Social and Economic Research.

Utter, J. & Denny, S. (2016) Supporting Families to Cook at Home and Eat Together: Findings From a Feasibility Study. *Journal of Nutrition Education and Behavior*, 48 (10): 716-722.e711.

Valdes, J., Rodriguez-Artalejo, F., Aguilar, L., Jaen-Casquero, M. B. & Royo-Bordonada, M. A. (2013) Frequency of family meals and childhood overweight: a systematic review. *Pediatric Obesity*, 8 (1): e1-e13.

van Hook, J. & Baker, E. (2010) Big Boys and Little Girls: Gender, Acculturation, and Weight among Young Children of Immigrants. *Journal of Health and Social Behavior*, 51 (2): 200-214.

Van Hook, J. & Stamper Balistreri, K. (2007) Immigrant generation, socioeconomic status, and economic development of countries of origin: A longitudinal study of body mass index among children. *Social Science & Medicine*, 65 (5): 976-989.

van Jaarsveld, C. H. M. & Gulliford, M. C. (2015) Childhood obesity trends from primary care electronic health records in England between 1994 and 2013: population-based cohort study. *Archives of Disease in Childhood*, 100 (3): 214-219.

Vaughan, L. T. (2011) A socio-cultural study investigating the influences on food and lifestyle choices, and the cultural transition, of British Bangladeshis living in Tower Hamlets East London. PhD Thesis. City University London.

Veitch, J., Bagley, S., Ball, K. & Salmon, J. (2006) Where do children usually play? A qualitative study of parents' perceptions of influences on children's active free-play. *Health & Place*, 12 (4): 383-393.

Veitch, J., Salmon, J. & Ball, K. (2010) Individual, social and physical environmental correlates of children's active free-play: a cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity*, 7 (1): 11.

Vidmar, S., Carlin, J., Hesketh, K. & Cole, T. (2004) Standardizing anthropometric measures in children and adolescents with new functions for egen. *Stata Journal*, 4 (1): 50-55.

Vidmar, S. I., Cole, T. J. & Pan, H. (2013) Standardizing anthropometric measures in children and adolescents with functions for egen: Update. *Stata Journal*, 13 (2): 366-378.

Viner, R. M., Cole, T. J., Fry, T., Gupta, S., Kinra, S., McCarthy, D., Saxena, S., Taylor, S., Wells, J. C., Whincup, P. & Zaman, M. J. (2010) Insufficient evidence to support separate BMI definitions for obesity in children and adolescents from south Asian ethnic groups in the UK. *International Journal of Obesity (London)*, 34 (4): 656-658.

Walton, K., Simpson, J. R., Darlington, G. & Haines, J. (2014) Parenting stress: a cross-sectional analysis of associations with childhood obesity, physical activity, and TV viewing. *BMC Pediatrics*, 14 244.

Wang, Y. (2002) Is obesity associated with early sexual maturation? A comparison of the association in American boys versus girls. *Pediatrics*, 110 (5): 903-910.

Waters, E., de Silva-Sanigorski, A., Hall, B. J., Brown, T., Campbell, K. J., Gao, Y., Armstrong, R., Prosser, L. & Summerbell, C. D. (2011) Interventions for preventing obesity in children. *Cochrane Database of Systematic Reviews*, (12): CD001871.

Wells, G., Shea, B., O'Connell, D., Peterson, J., Welch, V., Losos, M. & Tugwell, P. (2018) *The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses*. [online] Available from: http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp (Accessed 23rd May 2018).

Wells, J. C. K. (2009) Thrift: a guide to thrifty genes, thrifty phenotypes and thrifty norms. *International Journal Of Obesity*, 33: 1331.

Weng, S. F., Redsell, S. A., Swift, J. A., Yang, M. & Glazebrook, C. P. (2012) Systematic review and meta-analyses of risk factors for childhood overweight identifiable during infancy. *Archives of Disease in Childhood*, 97 (12): 1019-1026.

Wheway, R. (2014) *IS MY NEIGHBOURHOOD SUITABLE FOR CHILDREN? "A CHECKLIST"* [online] Available from: http://www.childrensplayadvisoryservice.org.uk/pdf_files/Publications/Neighbourhood_checklist.pdf (Accessed 21st May 2018).

Whitaker, K. L., Jarvis, M. J., Beeken, R. J., Boniface, D. & Wardle, J. (2010) Comparing maternal and paternal intergenerational transmission of obesity risk in a large population-based sample. *The American Journal of Clinical Nutrition*, 91 (6): 1560-1567.

White, M., Adams, J. & Heywood, P. (2009) How and why do interventions that increase health overall widen inequalities within populations? In: Babones, S. eds. *Health, inequality and society*. Bristol: Policy Press: 64-81.

Williams, J., Scarborough, P., Matthews, A., Cowburn, G., Foster, C., Roberts, N. & Rayner, M. (2014) A systematic review of the influence of the retail food environment around schools on obesity-related outcomes. *Obesity Reviews*, 15 (5): 359-374.

Williams, J., Scarborough, P., Townsend, N., Matthews, A., Burgoine, T., Mumtaz, L. & Rayner, M. (2015) Associations between Food Outlets around Schools and BMI among Primary Students in England: A Cross-Classified Multi-Level Analysis. *PLoS One*, 10 (7): e0132930.

Wilson, S. M. & Sato, A. F. (2014) Stress and paediatric obesity: what we know and where to go. *Stress and Health*, 30 (2): 91-102.

Woolley, C. M. (2009) Meeting the Mixed Methods Challenge of Integration in a Sociological Study of Structure and Agency. *Journal of Mixed Methods Research*, 3 (1): 7-25.

World Health Organization (2011) *Chapter 1: burden: mortality, morbidity and risk factors. The Global Status report on noncommunicable diseases 2010.* Geneva: World Health Organization.

World Health Organization (2012) *Population-based approaches to childhood obesity prevention*. Geneva: World Health Organization.

World Health Organization (2015) *Obesity and overweight. Fact sheet N°311.* [online] Available from: http://www.who.int/mediacentre/factsheets/fs311/en/ (Accessed 8th June 2015).

World Health Organization (2018) *Health Impact Assessment, Glossary of terms used*. [online] Available from: http://www.who.int/hia/about/glos/en/index1.html (Accessed 23rd May 2018).

Zilanawala, A., Davis-Kean, P., Nazroo, J., Sacker, A., Simonton, S. & Kelly, Y. (2015) Race/ethnic disparities in early childhood BMI, obesity and overweight in the United Kingdom and United States. *International Journal of Obesity (London)*, 39 (3): 520-529.